JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 47 November 1957 No. 11

ANTHROPOLOGY.—*The physique of the Seneca Indians of western New York State.* MARSHALL T. NEWMAN, U. S. National Museum.[1] (Communicated by T. D. Stewart.)

(Received July 26, 1957)

With few exceptions, the Indians of eastern North America were exterminated, absorbed, or driven west before physical anthropological studies came into being. As a result there are only four or five systematic descriptions of the physical characteristics of living Eastern Indians. In 1911 and 1915 Sir Francis Knowles measured Iroquois on the Six Nations Reserve Brant County, Ontario, and the Tonawanda Reservation in New York State while doing field work for the Geological Survey of Canada. Unfortunately only a few of his measurements have been published (Knowles, 1937), and since he died in 1953 the status of his scientific records is not clear. Prior to Knowles's work, the physical studies at the World's Columbian Exposition of 1893 in Chicago included Iroquois, Cherokee, Choctaw, Chickasaw, Delaware, Eastern Ojibway, and Micmac and Abenaki, but to date only mean statures and cephalic indices have been published (Boas, 1895). In the 1920's and 1930's, Hallowell (1929) and Strong (see Stewart, 1939) studied relatively intact northern Algonquian Indians in Labrador. In Oklahoma, Krogman (1935) and his coworkers made systematic physical studies of the Creek and Seminole who had been removed to the former Indian Territory from the Southeastern States. With these the only existing physical studies on living Eastern Indians, the deficiencies in in our knowledge are obvious. These deficiencies can only be partially filled by studies of archeologically documented Indian skeletal remains from the East, and these studies have yet to be carried out on a comprehensive basis.

Yet our knowledge of Eastern Indians has been augmented from an unexpected quarter, namely an obscure and probably now rare U. S. Sanitary Commission Report of almost a century ago. This report bears the unpromising title for Indian researches of *Investigations in the military and anthropological statistics of American soldiers*, authored by Benjamin A. Gould and published by the Riverside Press, Hurd & Houghton, Cambridge, in 1869. The purpose of Gould's study was to present measurements for clothing size tariffs; physical and educational performance data; and enlistment, desertion, and mortality figures for Union Army troops. Yet shortly after the conclusion of peace in the Civil War, Dr. George F. Buckley, chief examiner of the Sanitary Commission, and in effect their leading anthropometrist, made the first systematic study of the physique of living Eastern Indians. Gould's report does not say why, when the Civil War was over and mass troop recruiting was ended, Dr. Buckley measured all the available Iroquois men of military age on the reservations near Buffalo, N. Y. But it is apparent that this study was only part of an ambitious anthropometric survey the Sanitary Commission (precursor to the Public Health Service) was endeavoring to carry out. As Gould says, more Indians could have been measured if the War Department had consented

[1] Published by permission of the Secretary of the Smithsonian Institution.

to the study of the Indian prisoners of war then concentrated at Rock Island, Ill. But the Sanitary Commission's request was denied. At any rate, in 1865 Dr. Buckley repaired to the Iroquois reservations near Buffalo and during the course of physical examinations took measurements on 503 (14 more had previously been measured in the Army of the Potomac) Iroquois men 19–47 years of age "claiming and appearing to have no admixture of white blood." To this Gould (1869, p. 150) adds the comment, "how far this assumption [of racial purity] is correct must remain a matter of conjecture." On this point more can be said later (see p. 359).

Now while Gould's figures for mean stature, weight, and physiological observations for the Iroquois have had occasional reference in the anthropological literature, the rest of the measurements have been ignored. In the first place, the rigorousness of Dr. Buckley's techniques seems not to have been fully appreciated. The bulk of his measurements may have been dismissed by latter-day physical anthropologists as being old, unreliable, and not in accord with modern techniques. To an extent this is true (see pp. 360). In addition, physical anthropology until the past two decades concentrated upon head and face dimensions as diagnostic criteria of race. Dr. Buckley took a few head and face measurements (see Table 1) and perhaps his others were not considered useful. More recently, however, the revived interest in the influence of the environment upon body size and proportions renders body dimensions of much greater importance. Because of this, and since Dr. Buckley's measurements remain to this day the largest and most complete physical survey of a once powerful Eastern Indian group, it seems worthwhile to rerecord and interpret his data.

HISTORICAL SETTING

Before so doing, the Iroquois, who were lodged on the reservations near Buffalo when Dr. Buckley studied them, must be placed in their proper historical prospective. Dr. William N. Fenton (personal communication) advises me that while reservations near Buffalo are not specifically named by Gould they were probably the Tonawanda, Cattaraugus, and Allegany Reservations. It seems likely that all three were visited to provide a series of over 500 men of military age. Dr. Fenton surmises that these Iroquois were mainly Senecas, with some Cayugas, and from his published works (Fenton, 1956) the following Seneca history immediately prior to 1865 can be derived. Previous to 1779 the Senecas were practicing a highly successful maize agriculture and hunting economy in the rich Genesee and Finger Lakes area of New York State. In that year they were deprived of their lands and crops by General Sullivan's scorched earth campaign against them. The dispossessed Senecas then made a partial recovery at Buffalo Creek, only to have these lands sold out from under them in 1838, during that time of land pressures and political machinations known as the "Seven Years of Trouble." The Seneca generation between 1797 (The Treaty at Big Tree) and the "Seven Years of Trouble" experienced the beginnings of reservation life. This change was not for the best. As Fenton (1956, p. 573) says, "The first reaction to military disaster and deprivation of cornfields during the Revolution was to fall back on Niagara . . . , to live on rations and cook out of iron kettles. The British Commandant at Niagara was really hardpressed, during these years, to feed and clothe the hungry and ragged crowd."

In 1845 the dispirited Senecas were removed to Cattaraugus and other reservations near Buffalo. The Reverend Asher Wright and other missionaries went with them. Indeed it seems likely that 20 years later Reverend Wright was present at Cattaraugus when Dr. Buckely came to measure his people. During the 20 years and more of reservation life, cultural and possibly physical changes were wrought in the Senecas. It is common observation (Coon, Garn, and Birdsell, 1950, p. 44) that when natives are "taken off the range" they take on more body fat. Dietary changes toward high carbohydrate intake and lessened work load are almost certainly factors responsible for this. Dr. Fenton (personal communication) states that "there is a great deal of starch in the Seneca diet and has been since

TABLE 1.—ANTHROPOMETRIC DETERMINATIONS ON 508 ADULT MALE SENECA INDIANS FROM RESERVATIONS NEAR BUFFALO, N. Y. (AFTER GOULD 1869)

(In cm except where indicated)

Determination	Mean and S.E.	S.D.
Age—range 19–47 years	30.73	
Stature—without shoes	173.29 ± 0.153	3.45
Weight—without coat and shoes	73.85 kg.	
Body length—crotch to vertex	92.50	
Relative body length—to stature	53.34[1]	
Head and neck length—cervicale to vertex	24.26 ± 0.148	3.34
Trunk length—cervicale to crotch	68.25 ± 0.092	2.08
Total arm length—acromion to dactylion	78.21 ± 0.132	2.98
Upper arm length—acromion to elbow	34.39	
Lower arm and hand length—elbow to dactylion	43.27	
Brachial index	79.48[1]	
Relative arm length—to stature	45.2	
Crotch height (approximation of total leg length)	80.80 ± 0.156	3.52
Lower leg and foot length—floor to knee	48.28 ± 0.107	2.41
Foot length	25.71	
Hip breadth—bicristale	32.77 ± 0.141	3.18
Chest circumference—across nipples Insp.	98.86	
Chest circumference—across nipples Exp.	94.16	
Chest circumference—across nipples Mean	96.52	
Waist circumference	87.87 ± 0.141	2.12
Hip circumference—across trochanteria	98.96 ± 0.164	8.70
Head circumference—glabella to occiput	571.0 mm.	
Interocular breadth—between inner canthi	35.71	
Biocular breadth—between outer corners	102.31	
Bigonial breadth	131.50	
Lifting strength	190.20 kg.	
Pulse	76.31	
Respiration	15.83	
Other Iroquois (Knowles 1937)		
Stature—Six Nations Reservation (185)	170.45 ± 0.3	6.02
Tonawanda Reserve (32)	168.79 ± 0.65	5.42
Bizygomatic breadth—Six Nations (245)	144.63,± 0.23	5.41
Tonawanda (39)	144.87 ± 0.6	5.54
Nasal breadth—Six Nations (244)	40.79 ± 0.15	3.26
Tonawanda (38)	41.24 ± 0.33	3.17
Cephalic index—Six Nations (244)	79.14 ± 0.14	3.3
Tonawanda (29)	79.59 ± 0.43	3.96

[1] Calculated from means.

reservation life, both of maize and potatoes, bread, and pastry." That such physical changes took place in the Senecas is quite possible, especially in view of their large body weights (see p. 360). These changes were observed by Eggan and Pijoan (1943, pp. 15–16), for the Shoshone, who were placed on a high carbohydrate diet in their reservation life. This led to a cycle where the more the Shoshone ate the fatter they became. At 5,800 feet altitude great body bulk is somewhat more of a handicap in physical exertion than at sea level, so the fatter Shoshone got less exercise, and under a reservation ration system became even fatter. Returning to the Senecas, Dr. Fenton (personal communication) tells me he often discussed the matter of obesity in the Seneca with his late father and grandfather. He goes on to name stout Seneca of his own personal acquaintance, especially at Cattaraugus Reservation. There are also some very tall families there, with the men over 6 feet. In addition there is a smaller group of men of slighter body build who do not run to obesity.

In addition to any physical changes resulting from an altered way of life, it is clear that over the years the Iroquois absorbed outside racial elements. As Knowles (1937, pp. 40–41) says, by 1742, the Iroquois dependents and tributaries comprised the following tribes: Mohicans, Delawares, Shawnees, Conestogas, Nanticokes, and Tutelos. He found that a number of the Six Nations Reserve Iroquois had mixed Indian ancestry. White admixture of course became more prevalent in time. In 1911–1915, when Knowles studied about 420 Iroquois on the Six Nations Reserve, 40 of them claimed White ancestry. Of the 40, 15 claimed a White father or mother. Knowles (1937, p. 41) feels that the Tonawanda Senecas he saw were less mixed with White than the people on the Six Nations Reserve. Dr. Fenton (personal communication) states that the genealogies he collected in 1935–1937 bear out Knowles's contention. In commenting upon the Senecas measured by Dr. Buckley, Dr. Fenton (personal communication) thinks they may be largely fullbloods, but if their names were known (which they are not) he could probably ascertain those in the series with White admixture.

MEASURING TECHNIQUES

With the foregoing as background, we can return to the measurements. As chief examiner for the Sanitary Commission, Dr. Buckley was their most experienced anthropometrist. Furthermore, his visit to the

Senecas was at the end of his tour of measuring, by which time most of the technical difficulties should have been ironed out. For his instrumentation, Dr. Buckley had a specially made andrometer, calipers, measuring tape, facial angle instrument, platform balance scales weighing to one-fourth of a pound (Fairbanks-Morse), and a lifting strength dynamometer designed and constructed in New York (Gould 1869, pp. 458–459). The andrometer was an ingenious apparatus originally designed by an Edinburgh tailor, McDonald, for military clothing measurements and was reproduced in several models by American craftsmen for the Sanitary Commission. It was an upright wooden stand with ten horizontally and vertically moving gauges which were set to the measuring landmarks and read to the nearest one-tenth of an inch after the subject was properly posed. The subject stood still on the platform of the andrometer while the carriages for the horizontal gauges were adjusted to the height of his bony landmarks. The horizontal gauges were adjusted to measure neck, biacromial (and later full shoulder), and bicristal breadths. The vertical gauges were aligned with the top of the head, cervicale, crotch, and knee. Readings were then made. Stature; cervicale, perineum (crotch), and knee heights; and neck, shoulder, biacromial, and hip (bicristal) breadths were measured with the andrometer, as Gould (1869, p. 234) says, "with greater accuracy and rapidity than otherwise would be possible." All other lengths were measured by calipers, circumferences by tape.

As Table 1 indicates, some of the landmarks used by Dr. Buckley do not conform to modern techniques. For example, total leg length measured to the crotch as Dr. Buckley did is a standard tailoring measurement known as inseam length (cf. Randall and Baer, 1951, item 20), but it gives a dimension several centimeters less than the length to *trochanterion* (the top of the greater trochanter of the femur), which is the standard leg length of anthropometry. On the other hand, body length to the crotch is a close approximation to sitting height. Measuring lower leg length to the knee is again only an approximation of *tibiale* (the top edge of tibia on the mediale side), because Gould does not state whether the landmark was taken to be the top, bottom, or middle of the patella. Using the elbow as the landmark for lower arm length, however, is a very close approximation to *olecranon* when the arm is measured in extended position. The andrometer, or at least the way it was used, cannot be recommended for biacromial breadth since the Iroquois mean of 32.6 cm is impossibly low. Probably the sliding gauges of the andrometer were not set on the most lateral points on the acromial processes. The other measurements listed in Table 1 conform to modern techniques and also provide reasonable means.

Gould (1869, pp. 308–310) provides probable errors of the means for a few of the measurements. In Table 1 these have been converted into standard errors and standard deviations. All seem very low, especially for stature where a doubling of both constants would be more reasonable. Taken at face value, the other standard deviations suggest low variability in the present Seneca series.

INTERPRETATION OF THE MEASUREMENTS

In interpreting the bodily measurements of the Senecas, the most striking aspect is their large body size and lateral body build. The mean male stature of 173.3 cm (over 5 feet 8 inches) and weight of almost 74 kilograms (162.8 pounds) are the highest recorded for adequate series of New World aborigines. Several of the World's Columbian Exposition series (see Table 2), which may have been to some extent selected for tallness because of obvious exhibit advantages, closely approach the tall mean stature of the Senecas. No other Indians, even Gabel's (1949) Papago employed by the CCC and probably very well fed, can match the great body weight of the Seneca. Some of this great weight in the Senecas may be reservation fat, to wit, a 47-year-old weighing 276.8 pounds. Yet the great hip breadth, and the chest, waist, and hip circumferences bespeak the laterality of average body build in the Seneca beyond simple fat accumulations. Knowles (1937, p. 31) indicates that the great body size of the Iroquois is no new impression when he says:

In the letters of the Jesuit Fathers the Iroquois of New York State are constantly referred to as being tall, well-made men. Father Nau in the earlier part of the eighteenth century describes the Iroquois in the following terms (as translated): "Generally speaking you could find nowhere finer looking men. The savages are of better build than the French, but side by side with the Iroquois other savages seem dwarfed. Nearly all the men of our mission [Iroquois] are nearer six feet than five feet."

Table 2 demonstrates the preeminence of the Senecas in mean stature, although several Algonquian-speaking peoples are close competitors. As stated, there may have been some selection for tall stature in these series, while the Senecas reported upon here comprise the total available male population of military age.

TABLE 2.—MEAN STATURES OF EASTERN INDIAN MEN

(In cm. with standard errors)

Series	Author	Number	Mean
Iroquois—Seneca	Gould, 1869	508	173.29 ± 0.15
Iroquois—not specified	Boas, 1895	945	172.7
Ojibway—Eastern	Boas, 1895	143	172.3
Micmac and Abenaki	Boas, 1895	79	171.7
Delaware	Boas, 1895	43	171.5
Iroquois—Six Nations Reserve	Knowles, 1937	185	170.45 ± 0.3
Choctaw	Boas, 1895	260	170.0
Seminole—Oklahoma	Krogman, 1935	59	169.59 ± 1.17
Iroquois—Tonawanda Seneca	Knowles, 1937	32	168.89 ± 0.65
Chickasaw	Boas, 1895	59	167.9
Cherokee—Eastern	Boas, 1895	104	167.7
Montagnais—Abenaki	Hallowell, 1929	41	166.2 ± 1.36
Montagnais—Naskapi	Stewart, 1939	10	164.6

In addition, the measurements in Table 1 indicate quite high mean body (approximate sitting height) and arm length relative to stature. There can be no doubt that on the average the Senecas were very tall, long-trunked, and long-armed men of heavy, lateral body build. The very wide mean bigonial dimension, combined with Knowles's bizygomatic diameters, also bespeak very wide faces and jaws.

Gould (1937, pp. 308–310) noted that the mean body length, arm length especially in the forearm, and all lateral dimensions are perceptibly greater than in the White military population. That greater power went with this greater body size in the Senecas is indicated by their average lifting strength of 190 kg (419.3 pounds) as against 158 kg (348.9 pounds), the next highest military mean, in this case mulattoes. Anecdotal material on strength of the Senecas is provided by Dr. Fenton (personal communication), who says that in the estimation of John Holt, one-time trader to the Senecas at Quaker Bridge, a very plump Indian named Chauncey Johnny John was the strongest man he ever knew. Holt tells that one day in loading green oak railroad ties on a flat car, Chauncey trotted up the ramp with one under each arm! Although not readily converted into modern optical standards, visual acuity tested by distance at which double-face pica type could be distinctly read was also perceptibly higher in the Senecas than either the Whites or Negroes of the Union Army. Color-blindness, which unfortunately combines the red-green with other less common varieties, appears in 1.5 percent of the Senecas, as against 2.2 percent for White soldiers. Pulse and respiration are difficult to gauge by themselves although a mean pulse rate of 76 is very high for American Indians. If anything, the mean respiration rate of about 16 is the lowest recorded for New World aborigines.

CONCLUSIONS

The paucity of information on the physical anthropology of living Eastern Indians, the increased importance of body (as opposed to head and face) measurements in modern syntheses, and the obscurity of the original publication makes it worthwhile to appraise a physical study almost a century old on over 500 adult male Iroquois. This study was made on the total available male population of military age in what appears to be the Cattaraugus, Allegany, and Tonawanda Reservations. In all probability most, if not all, of these Iroquois were Senecas. They were selected only on the basis of military age and claim and appearance of being racially pure Indian. It seems likely that the actual proportion of White ancestry was very small. At the time of measuring, the Senecas had been living a reservation life for about two generations. With this life inevi-

tably went cultural and possibly physical changes. If anything, the physical changes were toward greater accumulations of body fat and physical softness.

Since the measurements were largely designed for clothes sizing determinations, some are not wholly in accord with modern racial anthropometry. Other measurements, however, are fully in keeping with modern practice, as witness Table 1. One experienced observer, the Chief Examiner of the U. S. Sanitary Bureau, performed all the measurements, and apparently did so with considerable technical rigor and adequate instrumentation.

Analyses of these measurements show that on the average the Senecas are the tallest in stature and heaviest in body weight of all known American Indians. Over and above any accumulation of body fat due to reservation life, the Senecas show an average lateral body build. In keeping with most Indians, the Senecas have long trunks and arms relative to stature. Wide faces and jaws are also typical. Performance data show the Senecas to be very superior in lifting strength and visual acuity to White and Negro military samples.

The importance of these physical data on the Senecas lies in the fact that they represent the largest carefully taken series of physical measurements on virtually the entire adult male population of a once numerous, powerful, and at the time largely unmixed Eastern Indian group.

LITERATURE CITED

BOAS, F. *Zur anthropologie der nord amerikanischen Indianer*. Verh. Berliner Ges., Anthrop., Ethnol., und Urgeschichte. 1895.

COON, C. S., GARN, S. M., and BIRDSELL, J. B. *Races: A study of the problems of race formation in man*. C. C. Thomas, Springfield, Ill., 1950.

EGGAN, F., and PIJOAN, M. *Some problems in the study of food and nutrition*. Amer. Indigena **3** (1). Mexico, D. F., 1943.

FENTON, WILLIAM N. *Toward the gradual civilization of the Indian natives: The missionary and linguistic work of Asher Wright (1803-1875) among the Senecas of Western New York*. Proc. Amer. Philos. Soc. **100** (6): 567–581. 1956.

GABEL, N. E. *A comparative racial study of the Papago*. Univ. New Mexico Publ. Anthrop., no. 4. 1949.

GOULD, B. A. *Investigations in the military and anthropological statistics of American soldiers*. U. S. Sanitary Commission Report. Cambridge, Mass., 1869.

HALLOWELL, A. I. *The physical characteristics of the Indians of Labrador*. Journ. Soc. Amer. Paris, **31**: 337–371. 1929.

KNOWLES, F. H. S. *Physical anthropology of the Roebuck Iroquois, with comparative data from other Indian tribes*. Nat. Mus. Canada Bull. 87, Anthrop. Ser. no. 22. 1937.

KROGMAN, W. M. *The physical anthropology of the Seminole Indians of Oklahoma*. Com. Ital. Studio Problemi Popolazine (3) **2**. 1935.

RANDALL, F. E., and BAER, M. J. *Survey of body size of Army personnel, male and female*. Environ. Protection Br. Rep. no. 122 (Reir). Quartermaster Climatic Res. Lab. 1951.

STEWART, T. D. *Anthropometric observations on the Eskimos and Indians of Labrador*. Publ. Field Mus. Nat. Hist., Anthrop. Ser., **31**: (1). 1939.

CATALYST FOR PARAHYDROGEN PRODUCTION SIMPLIFIES LIQUID HYDROGEN STORAGE PROBLEM

An unusually effective catalyst for converting ortho- to parahydrogen, developed by the Boulder (Colo.) Laboratories of the National Bureau of Standards, greatly simplifies the problem of liquid hydrogen storage. The research was conducted by the Cryogenic Engineering Laboratory as part of its general program to improve methods of efficient production and storage of liquid hydrogen and other cryogenic (low-temperature) materials and to facilitate their economical large-scale utilization. The present result was obtained in a project sponsored by the U. S. Atomic Energy Commission.

The fact that hydrogen consists of two kinds of molecules, known as orthohydrogen and parahydrogen, considerably complicates the problem of storing liquid hydrogen. This is because the ortho molecules are unstable at low temperatures and change into para molecules, liberating heat energy in the process and causing wasteful evaporation. Before the development of conversion catalysts, the problem could be met only by

the use of special refrigeration equipment to remove the heat generated during the relatively long time needed for the orthohydrogen to change to parahydrogen.

The development of effective catalysts has made possible the reliable, continuous production of liquid hydrogen having a high para content. The necessity for cumbersome and expensive refrigeration equipment to absorb the heat of conversion at the storage site is eliminated since liquid parahydrogen is transferred to storage directly from the liquefier where the catalysis takes place. Thus, efficient storage of the stable liquid parahydrogen can be accomplished by providing well-insulated storage vessels to protect the liquid from heat transferred from the environment.

TWO KINDS OF HYDROGEN

The two types of hydrogen molecules are distinguished by the orientations of their nuclear spins. Each hydrogen molecule is made up of two atoms, and the positively charged proton in the nucleus of each atom has associated with it a field which can be mathematically described as being caused by spinning of the proton itself. Since there are two atoms and therefore two "spinning" protons in each molecule, the two protons can be visualized as rotating either in the same direction or in opposite directions; that is, the "spins" can be either parallel or antiparallel. In the parallel case there exists an orthohydrogen molecule; in the anti-parallel case, a parahydrogen molecule.

There is also a difference in the energies associated with these two molecular varieties. The orthohydrogen molecule has "end-over-end" rotational energy, even at the absolute zero of temperature, while parahydrogen has negligible rotational energy at the boiling temperature of hydrogen. Thus a change from orthohydrogen to parahydrogen will result in a release of energy as the molecule goes from the first to the zero rotational energy level.

If one (but not both) of the atomic nuclei in a hydrogen molecule reverses its direction of rotation, it means that the molecule has changed from orthohydrogen to parahydrogen, or vice versa. A change of this kind cannot take place unless the molecule obtains (from other molecules or from some outside source) sufficient energy to get it past the "energy barrier" which confines it to its existing energy level. These conversions are continuously taking place among the millions of molecules in a volume of hydrogen gas or liquid, but eventually an equilibrium is reached when the number of ortho-to-para changes exactly equals the number of para-to-ortho changes. Thus the ratio of orthohydrogen to parahydrogen becomes fixed, and this equilibrium ratio depends on the temperature of the hydrogen.

At room temperature, for example, so-called "normal" hydrogen at equilibrium contains 75 percent orthohydrogen and 25 percent parahydrogen. At the boiling temperature (−423°F), the equilibrium ratio shifts to 0.2 percent orthohydrogen and 99.8 percent parahydrogen. Thus any change in temperature of the gas is accompanied by a change in the equilibrium ratio.

If normal gaseous hydrogen in equilibrium at room temperature is cooled rapidly to its liquefaction temperature, a fluid results which is in a highly unstable energy condition. That is, the conversion from ortho molecules to para molecules does not take place fast enough to maintain the rapidly shifting equilibrium ratio between the two varieties.

Ordinary freshly liquefied hydrogen therefore contains a much greater fraction of orthohydrogen than it will after reaching equilibrium. For this reason, the ortho-to-para conversion of molecules proceeds faster than the reverse para-to-ortho conversion. This means, of course, that energy is released within the liquid. This energy vaporizes some of the liquid even though the container insulation is perfect. It is therefore quite impossible to store ordinary unconverted liquid hydrogen efficiently unless a refrigerator is used to remove continuously the heat of ortho-to-para conversion.

The problem would be resolved if, while the hydrogen is cooling down in the liquefier (which is merely an efficient refrigerator), the ortho-to-para conversion could keep pace with the change in equilibrium ratio which occurs as the temperature goes down. This does not happen because each ortho molecule is "balanced", so to speak, in its unstable configuration and will remain so until some force influences one proton of the molecule more strongly than it does that proton's partner. If this happens, the disturbed proton will very likely "flip over" so that its spin orientation is opposite that of its partner, thereby forming a stable parahydrogen molecule.

The slow natural ortho-to-para conversion, which continues until eventually 99.8 percent of

the liquid is parahydrogen, is caused by a process known as "self catalysis." This means that if two orthohydrogen molecules approach one another closely enough, their magnetic fields interact (orthohydrogen molecules being magnetic) and unbalance the molecules so that a reorientation of spins takes place. However, the frequency of these events is such that it takes about a month for normal 25 percent-para liquid to convert to 90 percent-para. The heat energy released during this month of self conversion is enough to boil away 64 percent of the original liquid.

SELECTING A CATALYST

The conversion rate would be greatly accelerated if, while still in the liquefier, the hydrogen were to pass over a great many points of intense magnetic gradient so that each surplus ortho molecule would stand a good chance of having its unstable equilibrium unbalanced. This is precisely what the proper catalyst does.

For this, two things are essential: (1) a strong magnetic field, inhomogeneous on a scale of molecular dimensions, and (2) a physical structure which allows all of the hydrogen molecules to come into intimate contact with the magnetic centers. The first condition is met by choosing a material with high magnetic susceptibility, and the second (in the case of a solid catalyst) by obtaining an extremely fine porosity which results in a huge internal surface area. In addition, there is another mechanism that may play an important, if secondary, part in the process (and for which the evidence is more definite at higher temperatures). For this mechanism, also, the hydrogen should be exposed to the maximum possible surface area of the catalyst.

Many investigators have searched for catalysts suitable for promoting this conversion.[1] Workers at Los Alamos Scientific Laboratory succeeded in 1953 in modifying a 25 liter/hour hydrogen liquefier for the regular production of 85 percent para liquid. This achievement was followed shortly by the successful modification of the NBS hydrogen liquefier at the Boulder Laboratories to produce 240 liters per hour of 90–95 percent liquid parahydrogen.

Concurrent with these developments, the Cryogenic Engineering Laboratory in 1952 started a research program under the direction of D. H. Weitzel, sponsored by the AEC, to study and evaluate catalysts suitable for the production of liquid parahydrogen. W. V. Loebenstein of the surface chemistry laboratory in Washington joined the project for the first year of the work.

Hydrous ferric oxide was one of several catalyst materials suggested and prepared by Loebenstein. These catalysts, along with others prepared at Boulder, were evaluated for effectiveness in ortho-to-para conversion by Weitzel and coworkers. The most effective catalyst tested, by a considerable margin, was hydrous ferric oxide.

Hydrous ferric oxide results from the removal, through controlled heating, of entrained water from ferric hydroxide gel. The product thus obtained is hard and strong; and it has an available effective surface area, when measured by gas adsorption methods, of as much as 150 square meters per gram (about 16.8 acres per pound). Furthermore, since iron is ferromagnetic and therefore has very high magnetic susceptibility, it is not surprising that it has proved an unusually effective ortho-para conversion catalyst. Its high conversion efficiency permits the design of ortho-para converters about one-fortieth the size of those used in the early work at Los Alamos and the National Bureau of Standards. Thus the size of these installations used in connection with extremely large hydrogen liquefiers can be kept manageable.

Experiments have shown that conversion in the gas phase proceeds slower than conversion in the liquid phase. Data now exist permitting the prediction of catalyst quantities required to do an efficient job of gas-phase, as well as liquid-phase, conversion.

The Cryogenic Engineering Laboratory has also been doing research on materials and methods for improving liquid hydrogen storage dewar design. Both high vacuum and evacuated powder insulation techniques[2] have been investigated, along with novel insulating support methods. The information has been widely applied by commercial fabricators of this type of equipment and highly efficient storage dewars for liquid parahydrogen have resulted.

[1] For further technical details, see *Iron catalyst for production of liquid parahydrogen*, by D. H. Weitzel and O. E. Park, Rev. Sci. Instr. **27:** 57. Jan. 1956; *The regular production of 85 percent, para liquid hydrogen*, by E. R. Grilly, Rev. Sci. Instr. **24:** 899. 1953; *The liquefaction and storage of partially converted liquid hydrogen*, by E. R. Grilly, Rev. Sci. Instr. **24:** 1. 1953; *The para-hydrogen conversion at paramagnetic surfaces*, by H. S. Taylor and H. D. Diamond, Journ. Amer. Chem. Soc. **55:** 2613. 1933.

[2] Powders for low-temperature insulation, NBS Tech. News Bull. **41:** 87. June 1957.

MATHEMATICS.—*Some properties of Struve functions.* RICHARD K. COOK,[1] Bell Telephone Laboratories, Murray Hill, N. J.

(Received July 31, 1957)

EDITOR'S NOTE.—The Struve functions are closely related to the Bessel functions, which are solutions of a wave equation in cylindrical coordinates. They arise in diffraction problems. The following paper contains some manipulative techniques and results that should be useful to other workers in theoretical acoustics and optics.

A simple method for finding expansions of Struve functions $H_n(z)$ (n an integer) as a Neumann series of Bessel functions $J_n(z)$ is presented. New expansions of $H_\nu(z)/z^\nu$ as a Neumann series of $J_n(z)$ are given.

We obtain an addition formula for $H_0(x + y)$ as a Neumann expansion in $J_n(x)$, whose coefficients contain $H_n(y)$. This is got from Sonine's expansion for the hemicylindrical Weber functions, which differ from Struve functions only by a polynomial.

An addition formula for

$$H_0(\sqrt{Z^2 + z^2 - 2zZ\cos\Phi})$$

is obtained as a Neumann expansion in $J_n(z)$, whose coefficients contain incomplete Struve functions. This rather intricate addition formula reduces to a simple form for $H_0(\sqrt{z^2 - Z^2})/\sqrt{z^2 - Z^2}$ in which the coefficient of $J_n(z)$ is the product of a hemicylindrical trigonometric function of Z by a polynomial in z and Z.

The analysis and results follow Watson's notation [1][2].

1. *Neumann Expansions for* $H_n(z)$

An expansion for Struve functions, $H_\nu(z)$, has been given by Erdélyi et al. [2], p. 99. This was obtained from a Neumann expansion for a Lommel function of one variable.

A simple method for finding expansions for $H_n(z)$, $n = 0, 1, 2, 3, \cdots$ is as follows. Since

$$H_0(z) = \frac{2}{\pi}\int_0^{\frac{\pi}{2}} \sin(z\sin u)\,du$$

then substitution of Jacobi's Fourier series expansion for $\sin(z\sin u)$ and term-by-term integration gives

$$H_0(z) = \frac{4}{\pi}\sum_{\mu=1,3,5,\cdots}^{\infty}\frac{J_\mu(z)}{\mu} \qquad (1)$$

the integration being valid because of the uniform convergence of the Fourier series. This Neumann expansion is convergent for all values of z in the complex plane. Formula (1) is the same as Erdélyi's for $\nu = 0$.

Expansions for $H_1(z)$, $H_2(z)$, $\cdots$, are readily obtained from formula (1) by means of the recurrence relations for Struve functions given in Watson, p. 329, combined with the well-known recurrence relations for Bessel functions. The results for $H_1(z)$ and $H_2(z)$ are

$$\begin{aligned} H_1(z) &= \frac{2}{\pi} - \frac{2}{\pi}J_0(z) + \frac{4}{\pi}\sum_{\mu=2,4,6,\cdots}^{\infty}\frac{J_\mu(z)}{\mu^2 - 1} \\ H_2(z) &= \frac{2z}{3\pi} + \frac{4}{\pi}\sum_{\mu=1,3,5,\cdots}^{\infty}\frac{\mu J_\mu(z)}{\mu^2 - 4} \end{aligned} \qquad (2)$$

and these are convergent for all values of z. The functions

$$H_1(z) - \frac{2}{\pi} \text{ and } H_2(z) - \frac{2z}{3\pi}$$

are respectively the same as Weber's functions $-E_1(z)$ and $-E_2(z)$, and the formulas (2) agree with those obtainable from Erdélyi, pp. 42 and 64, for Neumann expansions of Weber functions.

2. *Neumann Expansions for* $H_\nu(z)/z^\nu$

Struve functions $H_\nu(z)$ are defined by

$$\sqrt{\pi}\,2^{\nu-1}\Gamma(\nu + \tfrac{1}{2})H_\nu(z)/z^\nu = \int_0^{\frac{\pi}{2}}\cos^{2\nu}\Phi\sin(z\sin\Phi)\,d\Phi = I(z)$$

[1] Now at the National Bureau of Standards, Washington, D.C.

[2] The numbers in brackets refer to literature references at the end of this paper.

and this is valid for all values of z if $Re(\nu) > -\frac{1}{2}$. Replace $\sin(z \sin \Phi)$ in the integrand by its Fourier series. Then term-by-term integration of the series is valid because of its uniform convergence, and so

$$I(z) = 2 \sum_{\mu=1,3,5,\cdots}^{\infty} J_\mu(z) \cdot \int_0^{\pi/2} \cos^{2\nu} \Phi \sin \mu\Phi \, d\Phi \tag{3}$$

The trigonometric integrals can be evaluated by expansion of $\sin \mu\Phi$ as a polynomial in $\sin \Phi$, see for example Watson, p. 33. The coefficient of $J_\mu(z)$ will then appear as a sum of several Eulerian integrals of the first kind. The final result, valid for all values of z if $Re(\nu) > -\frac{1}{2}$, is

$$\frac{H_\nu(z)}{z^\nu} = \frac{1}{2^\nu} \sum_{\mu=0}^{\infty} \left[\sum_{\lambda=0}^{\mu} \frac{(-)^\lambda (\mu + \lambda)!\,(2\mu + 1)}{(\mu - \lambda)!\,\Gamma(\lambda + \frac{3}{2})\Gamma(\nu + \lambda + \frac{3}{2})} \right] J_{2\mu+1}(z) \tag{4}$$

which is the Struve function counterpart of Watson's expansion (p. 139) for $J_\nu(z)/z^\nu$ as a Neumann series.

Some special cases of formula (4) are of interest. Since $H_{\frac{1}{2}}(z) = \sqrt{2/\pi z}(1 - \cos z)$, then substitution of $\nu = \frac{1}{2}$ into formula (4) yields the interesting expansion

$$\frac{1 - \cos z}{z} = J_1(z) + J_2(z) + \frac{J_3(z) + J_7(z)}{3} + \frac{J_9(z) + J_{11}(z)}{5} + \cdots \tag{5}$$

which can be readily obtained also by direct evaluation for $\nu = \frac{1}{2}$ of the coefficients of $J_\mu(z)$ in formula (3).

For $\nu = 1$ and $\nu = 2$, the Neumann expansion (4) has simple coefficients for $J_{2\mu+1}(z)$. These can be got by direct evaluation of the trigonometric integrals in formula (3). The expansions are

$$\frac{H_1(z)}{z} = \frac{4}{\pi} \sum_{\mu=1,3,\cdots}^{\infty} \frac{\mu^2 - 2}{\mu(\mu^2 - 4)} J_\mu(z)$$

$$\frac{H_2(z)}{z^2} = \frac{4}{\pi} \sum_{\mu=1,3,\cdots}^{\infty} \frac{\mu^4 - 16\mu^2 + 24}{\mu(\mu^2 - 4)(\mu^2 - 16)} J_\mu(z)$$

3. *Addition Formulas*

An addition formula for $H_0(x + y)$ can be obtained from formula (1). A more direct method is to use Sonine's expansion (see Watson, p. 354)

$$E_n(x + y) = \sum_{\mu=-\infty}^{\infty} E_{n-\mu}(y) J_\mu(x)$$

which is valid for the class of hemi-cylindrical functions, of which the Weber functions $E_n(z)$ are members. Since

$$E_0(x + y) = -H_0(x + y),$$

$$E_{-n}(y) = (-)^n E_n(y),$$

$$\text{and } J_{-n}(x) = (-)^n J_n(x),$$

then

$$E_0(x + y) = E_0(y) J_0(x) + 2 \sum_{\mu=1}^{\infty} (-)^\mu E_\mu(y) J_\mu(x)$$

$$H_0(x + y) = H_0(y) J_0(x) - 2 \left[H_1(y) - \frac{2}{\pi} \right] J_1(x) + 2 \left[H_2(y) - \frac{2y}{3\pi} \right] J_2(x) + \cdots \tag{6}$$

In the latter formula, the coefficients (in the square brackets) of $J_n(x)$ are Weber functions,

$$-E_n(y) = H_n(y) - \text{the polynomial terms in the asymptotic expansion of } H_n(y).$$

An expansion for $H_0(\omega)$, where

$$\omega = \sqrt{Z^2 + z^2 - 2zZ \cos \Phi},$$

is obtainable as a Neumann series in $J_m(z)$, similar to the well known expansion for $J_0(\omega)$. The result for $H_0(\omega)$ is considerably more intricate, however. The quantities ω, Z, z, and the angles Φ and Ψ are not all independent. When real, they are related as shown in the sketch (Fig. 1).

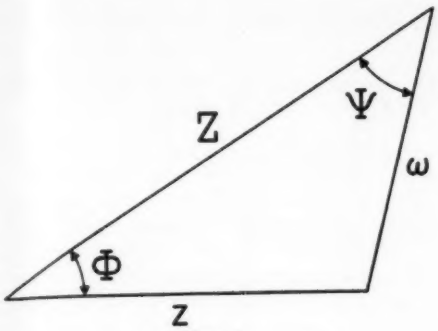


FIG. 1

Graf's formula (Watson, p. 359, et seq.) is required. The formula can be written

$$J_\mu(\omega) = \sum_{m=-\infty}^{\infty} J_{\mu+m}(Z)J_m(z)\cos(m\Phi - \mu\Psi)$$

$$= J_\mu(Z)J_0(z)\cos\mu\Psi + \cos\mu\Psi\sum_{m=1}^{\infty}[J_{\mu+m}(Z) + (-)^m J_{\mu-m}(Z)] \times J_m(z)\cos m\Phi + \sin\mu\Psi \cdot \sum_{m=1}^{\infty}[J_{\mu+m}(Z) + (-)^{m+1}J_{\mu-m}(Z)] \cdot J_m(z)\sin m\Phi$$

Hence from equation (1),

$$\frac{\pi}{4}H_0(\omega) = M_0(Z,\Psi)J_0(z) + \sum_{m=1}^{\infty} M_m(Z,\Psi)J_m(z)\cos m\Phi + \sum_{m=1}^{\infty} N_m(Z,\Psi)J_m(z)\sin m\Phi \quad (7)$$

where

$$M_0(Z,\Psi) = \sum_{\mu=1,3,\cdots}^{\infty} \frac{J_\mu(Z)\cos\mu\Psi}{\mu}$$

$$M_m(Z,\Psi) = \sum_{\mu=1,3,\cdots}^{\infty} \cdot \frac{J_{\mu+m}(Z) + (-)^m J_{\mu-m}(Z)}{\mu}\cos\mu\Psi$$

$$N_m(Z,\Psi) = \sum_{\mu=1,3,\cdots}^{\infty} \cdot \frac{J_{\mu+m}(Z) + (-)^{m+1}J_{\mu-m}(Z)}{\mu}\sin\mu\Psi$$

With the aid of the above Fourier series, the M's and N's can be expressed in terms of familiar functions. In what follows, summations over μ will be for the odd numbers, $\mu = 1, 3, 5, \cdots, \infty$.

Consider first

$$M_0(Z,\Psi) = \sum_{\mu} \frac{J_\mu(Z)\cos\mu\Psi}{\mu}$$

$$\frac{\partial M_0}{\partial\Psi} = -\sum_{\mu} J_\mu(Z)\sin\mu\Psi = -\frac{\sin(Z\sin\Psi)}{2}$$

from Jacobi's expansion. Therefore

$$M_0(Z,\Psi) = \tfrac{1}{2}\int_{\Psi}^{\pi/2}\sin(Z\sin u)\,du = \frac{\pi}{4}\left[\frac{2}{\pi}\int_0^{\pi/2}\sin(Z\sin u)\,du - \frac{2}{\pi}\int_0^{\Psi}\sin(Z\sin u)\,du\right] = \frac{\pi}{4}[H_0(Z) - H_0(Z,\Psi)]$$

and $H_0(Z, \Psi)$ can be called an incomplete Struve function. $H_0(Z, 0) = 0$ and $H_0(Z, \pi/2) = H_0(Z)$.

In a similar way $M_m(Z, \Psi)$ can be found in terms of $E_m(Z)$ and $E_m(Z, \Psi)$, an incomplete Weber function. The details of the analysis are omitted, except for presentation of the following Fourier series, which can be regarded as generalizations of Jacobi's expansions:

$$\frac{\partial M_m}{\partial\Psi} = -\sum_{\mu}[J_{\mu+m}(Z) + (-)^m J_{\mu-m}(Z)]\sin\mu\Psi$$

$$= \sin m\Psi\cos(Z\sin\Psi)\ (m \text{ odd})$$

$$= -\cos m\Psi\sin(Z\sin\Psi)\ (m \text{ even})$$

These series are readily established with the aid of Bessel's integrals for $J_{\mu+m}(Z)$ and $J_{\mu-m}(Z)$. Finally,

$$M_m(Z,\Psi) = -\frac{\pi}{2}E_m(Z) + \frac{\pi}{2}E_m(Z,\Psi),$$

where the incomplete Weber function $E_m(Z, \Psi)$ is given by

$$E_m(Z, \Psi) = \frac{2}{\pi}\int_0^{\Psi} \sin mu \cos (Z \sin u)\, du (m \text{ odd})$$

$$= -\frac{2}{\pi}\int_0^{\Psi} \cos mu \sin (Z \sin u)\, du (m \text{ even})$$

We note that $E_m(Z, 0) = 0$, and

$$E_m(Z, \pi/2) = E_m(Z).$$

The analysis for the $N_m(Z, \Psi)$ shows that they are expressible in terms of elementary functions. The details are again omitted, except for presentation of the following Fourier series, which are additional generalizations of Jacobi's expansions:

$$\frac{\partial N_m}{\partial \Psi} = \sum_{\mu} [J_{\mu+m}(Z) + (-)^{m+1} J_{\mu-m}(Z)] \cos \mu\Psi$$

$$= \cos m\Psi \cos (Z \sin \Psi) \ (m \text{ odd})$$

$$= \sin m\Psi \sin (Z \sin \Psi) \ (m \text{ even})$$

Finally,

$$N_m(Z, \Psi) = \int_0^{\Psi} \cos mu \cos (Z \sin u)\, du (m \text{ odd})$$

$$= \int_0^{\Psi} \sin mu \sin (Z \sin u)\, du (m \text{ even})$$

By direct integration,

$$N_1(Z, \Psi) = \frac{\sin (Z \sin \Psi)}{Z}$$

$$N_2(Z, \Psi) = 2 \times \frac{\sin (Z \sin \Psi) - (Z \sin \Psi) \cos (Z \sin \Psi)}{Z^2}$$

Since the N_m's are hemicylindrical functions of Z, the higher orders can be found from N_1 and N_2 by means of the recurrence relation

$$N_{m-1} - N_{m+1} = 2\frac{\partial N_m}{\partial Z}$$

It is to be noted that $N_m(Z, 0) = 0$; write $N_m(Z, \pi/2) = N_m(Z)$. Thus

$$N_1(Z) = \frac{\sin Z}{Z}$$

$$N_2(Z) = 2 \times \frac{\sin Z - Z \cos Z}{Z^2}$$

$$N_3(Z) = -3 \times \frac{\sin Z}{Z} + 8 \times \frac{\sin Z - Z \cos Z}{Z^3} \text{ etc.}$$

Suppose $\Phi = \pi$; then $\Psi = 0$ and $\omega = Z + z$. $M_0(Z, 0) = (\pi/4)H_0(Z)$, $M_m(Z, 0) = -(\pi/2)E_m(Z)$, and $N_m(Z, 0) = 0$. Also, $H_0(\omega) = H_0(Z + z)$. Therefore formula (7) reduces to (6).

Suppose $\Psi = \pi/2$; then $\omega = \sqrt{z^2 - Z^2}$. $M_0(Z, \pi/2) = 0$, $M_m(Z, \pi/2) = 0$, and $N_m(Z, \pi/2)$ are the hemi-cylindrical functions given above. Formula (7) reduces to

$$\frac{\pi}{4} H_0(\sqrt{z^2 - Z^2}) = \sum_{m=1}^{\infty} N_m(Z) J_m(z) \sin m\Phi$$

$$= \frac{\sin Z}{Z} J_1(z) \sin \Phi + 2\frac{\sin Z - Z \cos Z}{Z^2} \times J_2(z) \sin 2\Phi + \cdots$$

where $\sin \Phi = \sqrt{z^2 - Z^2}/z$, $\sin 2\Phi = 2Z\sqrt{z^2 - Z^2}/z^2$, $\sin 3\Phi = (4Z^2 - z^2)\sqrt{z^2 - Z^2}/z^3$, etc.

REFERENCES

(1) WATSON, G. N. *Theory of Bessel Functions*, ed. 2. Cambridge University Press, 1944.

(2) ERDÉLYI, A., MAGNUS, W., OBERHETTINGER, F., and TRICOMI, F. G. *Higher Transcendental functions*, **2**. McGraw-Hill Book Co., New York, 1953.

PALEONTOLOGY.—*Two aberrant crinoid specimens.* HARRELL L. STRIMPLE, Copan, Okla.

(Received June 20, 1957)

Aberrant forms of life are not acceptable as taxonomic units, but it is thought the specimens discussed herein might provide useful information in genetic or future taxonomic studies.

An abnormal crinoid calyx of *Laudonocrinus* sp. undt., with a diameter of 6.5 mm, was collected by Arthur Bowsher, now with the U. S. Geological Survey, while a student several years ago at the University of Tulsa. The exposure was located in the center of the north half of section 31, township 23 N., range 12 E., Osage County, Okla., and was designated as the Avant limestone formation, Ochelata Group, Pennsylvanian. The specimen is in the U. S. National Museum and camera-lucida drawings are given below.

As will be noted, the posterior interradius of this specimen is occupied by six elements. Normal representatives of the genus have only three elements, which are the radianal (RA), first anal (X), and right second anal (RX). The plates in the present specimen are designated as follows: The element to the right and below the left posterior radial (LPR) is termed inferradial (LPiR); the element to the right of LPR and LPiR is termed the first anal (X); the element directly above X and to the right of the LPR, being the second anal, is termed superanal (sX); the element to the right of LPiR and below RA is termed inferradianal (iRA); the element above iRA and to the right of X is termed radianal (RA); the element above RA and to the right of sX is termed right second anal (RX). Of the above elements the three normal plates for the genus are RA, X and RX as has been previously noted. Some of the more ancient Paleozoic crinoids possess an inferradianal or superradial, but such elements are not found in late Paleozoic crinoids.

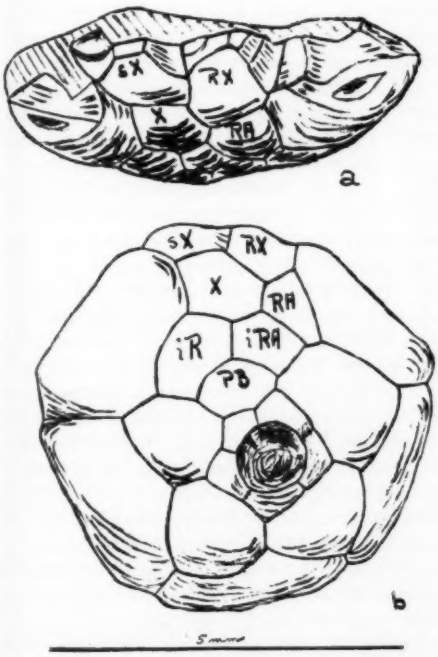


FIG. 1.—*a, b, Laudonocrinus*, sp. undt., view of dorsal cup from posterior and below.

Another abnormal crinoid calyx was collected several years ago by Claude Bronaugh, Oklahoma Military Academy, in the Fayettville formation, Chester, Mississippian, some three miles southwest of Afton, Okla. It is a representative of *Phanocrinus alexanderi* Strimple (1948), with a diameter of 10.3 mm, and has five plates within the posterior interradius. The plates are referred to as follows: LPiR, X, sX, RA and RX. The specimen thus differs from the aberrant *Laudonocrinus* in the absence of iRA.

The two specimens are of widely different ages yet have in common two elements not found in late Paleozoic crinoids, which are LPiR and sX. The author is unable to attach any special significance to this occurrence, but it is hoped they will be useful in subsequent studies.

LITERATURE CITED

STRIMPLE, HARRELL L. *Notes on* Phanocrinus *from the Fayettville formation of northeastern Oklahoma.* Journ. Pal. **22:** 490–493. 1948.

ZOOLOGY.—*Emendation of the foraminiferal genus* Palmerinella *Bermudez, 1934, and erection of the foraminiferal genus* Helenia. J. B. SAUNDERS, Trinidad Oil Co., Pointe-a-Pierre, Trinidad, B. W. I. (Communicated by Alfred R. Loeblich, Jr.)

(Received July 1, 1957)

During sampling of shallow water sediments off the west coast of Trinidad, B.W.I., Foraminifera belonging to the genus *Palmerinella* Bermudez, 1934, were found. Subsequent investigation showed that an emendation of the type species, *Palmerinella palmerae* Bermudez, and therefore of the genus, would be necessary. Examination of topotype material supplied by Dr. Bermudez and of the cotypes in the U. S. National Museum in Washington enabled the following redefinition to be prepared. A new subspecies, *Palmerinella palmerae diminuta*, has been based on the Trinidad specimens.

Also in Recent sediments from Trinidad was found a foraminifer which seemed worthy of description because of its distinct apertural characteristics. Being restricted to inshore brackish-water sediments, it was felt that if the species should subsequently be found in fossil assemblages an understanding of its nature would be of value paleoecologically. While this paper was in preparation the species was described by Warren (1957) under the name *Pseudoeponides anderseni*. However, the present writer does not agree with the assignment of this species to the genus *Pseudoeponides*, and it is here made the type species for the proposed new genus, *Helenia*.

Sincere thanks are due to Dr. Alfred R. Loeblich, of the U. S. National Museum, who arranged for the very fine drawings to be prepared by Mr. Lawrence and Mrs. Patricia Isham, scientific illustrators at the Museum, and communicated this note for publication to this JOURNAL. Thanks are also due to Dr. Hans Bolli for a critical reading of the manuscript and to the management of the Trinidad Oil Co. for permission to use their laboratory facilities.

Genus **Palmerinella** Bermudez, 1934, emended

Original reference.—Mem. Soc. Cubana Hist. Nat. **8** (2): 83, 1934.

Type species.—*Palmerinella palmerae* Bermudez, 1934.

Emended diagnosis.—Test free, trochospiral to almost planispiral; all chambers usually visible on the spiral side though early chambers may be partly or wholly obscured by a calcite plug; on the umbilical side, earlier chambers often obscured by a calcite plug. On the umbilical side supplementary chambers may be present between the chambers of the last whorl and the central plug though these are apparently sometimes obscured by the latter. Wall calcareous, perforate. Sutures curved, slightly depressed, flush with the surface or sometimes slightly raised. Aperture in the final chamber consisting of a pair of slits running almost the whole length of the terminal face and separated by a vertical septum; the slit towards the spiral side completely surrounded by a lip, that towards the umbilical side surrounded by a lip except at the interiomarginal end where it opens between the last chamber and the umbilical plug. On earlier chambers each slit aperture is closed by a calcite septum penetrated by pores.

Remarks.—Emendation of the type species of *Palmerinella* Bermudez necessitates a similar revision of the generic diagnosis. *Palmerinella* is most closely related to *Eponidella* Cushman and Hedberg, which it resembles in general shape of the test, wall structure, and presence of supplementary chambers on the umbilical side and from which it differs in apertural characters. In *Palmerinella* the aperture is always divided by a vertical septum, always opens onto the umbilical surface, and is closed by thin calcite septa in all but the last chamber, whereas in *Eponidella* the aperture, though interiomarginal extraumbilical in position in the early stages, is said to trend toward an areal position in the adult, is not divided by a vertical septum though there may be a tendency for a horizontal septum to appear and has not been recorded closed in early chambers.

Stainforth and Stevenson (1946) described *Palmerinella thalmanni* from the Miocene of

Ecuador; this species does not belong in the genus *Palmerinella*, as its aperture is a simple vertical slit in the centre of the terminal face of the chamber; it seems probable that this species should be removed to the genus *Ganella* Aurouze and Boulanger.

Palmerinella palmerae palmerae Bermudez, emended

Figs. 6a, 7

Palmerinella palmerae Bermudez, Mem. Soc. Cubana Hist. Nat. **8**(2): 83–86, figs. 1–3. 1934.

Emended diagnosis.—Test free, low trochospiral, almost planispiral in the adult and may even tend toward uniserial arrangement of last chambers in some large, possibly gerontic forms; all chambers usually visible on the spiral side though early chambers may be partly or wholly obscured by a semitransparent calcite plug; earlier chambers often obscured by a plug of calcite on the umbilical side; small supplementary chambers may be present between the chambers of the last whorl and the central umbilical plug though these are apparently sometimes obscured by the latter. Axial periphery rounded, equatorial periphery slightly lobate. Chambers numerous, 10 to 20 in the last whorl, with an average of 14 to 16. Wall calcareous, vitreous, coarsely perforate. Sutures distinct, curved, flush with the surface or slightly raised. Aperture on the final chamber consisting of a pair of slits running almost the whole length of the terminal face and separated by a vertical septum; the slit towards the spiral side completely surrounded by a prominent lip, the slit towards the umbilical side surrounded by a lip except at the interiomarginal end where it opens between the last chamber and the umbilical plug. In all earlier chambers, the two slit apertures are closed by thin calcite septa each penetrated by a linear series of round or elongate pores.

Greatest diameter of lectotype (here designated) (Cushman Coll. 22707a) 0.52 mm, thickness 0.17 mm, greatest diameter of figured paratype (Cushman Coll. 22707b) 0.6 mm, thickness 0.2 mm, greatest diameter of unfigured paratype (Cushman Coll. 22707c) 0.55 mm, thickness 0.17 mm.

Remarks.—The discovery in Trinidad of Foraminifera belonging to the genus *Palmerinella* Bermudez led the present author to realize that the species *Palmerinella palmerae* Bermudez had not been sufficiently fully described. Dr. Bermudez was kind enough to send topotype material to the author and to say that he would be pleased to see the species and genus redefined. During examination of the topotype material, it become apparent that the Trinidad specimens differed considerably from what had been described by Bermudez as *Palmerinella palmerae*; it seems necessary therefore to place them in a separate subspecies. The original types described by Bermudez from the Playa de Batabanó, Cuba are now regarded as belonging to the restricted subspecies, *Palmerinella palmerae palmerae* Bermudez, while the specimens from the west coast of Trinidad are made the basis for *Palmerinella palmerae diminuta* n. subsp.; notes on the differences between the two subspecies are given below in the remarks on the new subspecies.

Examination of the three cotypes erected by Bermudez and deposited in the collection of the U. S. National Museum in Washington showed that these exhibit well the apertural features of the species. On one specimen (Cushman Coll. 22707a) the final chamber is present and the two slit like apertures are open; this has been designated as the lectotype of *Palmerinella palmerae palmerae* (figs. 6a–c). The other two cotypes are broken specimens in which at least one of the chambers of the last whorl has been lost; both these specimens show the apertures closed by septa which are penetrated by rows of pores. These two cotypes are designated as paratypes (Cushman Coll. 22707b, 22707c), and one of them is illustrated here (Fig. 7).

Palmerinella palmerae palmerae has been seen by the present author only in material from the type locality as designated by Bermudez.

Locality.—Lectotype (Cushman Coll. 22707a) and paratypes (Cushman Coll. 22707b, c) from Playa de Batabanó, Province Habaná, Cuba.

Palmerinella palmerae diminuta, n. subsp.

Figs. 3–5c

Diagnosis.—Test free, low trochospiral, almost planispiral in the adult; all chambers usually visible on the spiral side, though early chambers may be obscured by a semitransparent calcite plug; on the umbilical side, early chambers often obscured by a calcite plug; small supplementary chambers are present between the chambers of the last whorl and the umbilical

plug. Axial periphery rounded, equatorial periphery slightly lobate. Chambers numerous, 10 to 14 in the last whorl, with an average of 12. Wall calcareous, vitreous, coarsely perforate. Sutures distinct, slightly curved, slightly depressed. Aperture of the final chamber consisting of a pair of slits running almost the whole length of the terminal face and separated by a vertical septum; the slit towards the spiral side completely surrounded by a prominent lip, the slit toward the umbilical side surrounded by a lip except at the interiomarginal end where it opens between the last chamber and the umbilical plug. In all earlier chambers, the two slitlike apertures are closed by thin calcite septa each penetrated by a linear series of rounded pores.

Greatest diameter of holotype (U.S.N.M. P6493) 0.33 mm, thickness 0.13 mm, greatest diameter of paratype (U.S.N.M. P6494a) 0.29 mm, thickness 0.13 mm, greatest diameter of paratype (U.S.N.M. P6494b) 0.32 mm, thickness 0.13 mm.

Remarks.—This subspecies differs from *Palmerinella palmerae palmerae* in its smaller average size, greater thickness relative to diameter, smaller average number of chambers in the last whorl (12 as against 14 to 16), less sigmoid sutures, less tendency to an increase in height of the last chamber, and a tendency for more involute coiling. Whereas in *Palmerinella palmerae palmerae* the supplementary chamberlets are often obscured by the umbilical plug, in *Palmerinella palmerae diminuta* they are normally distinct.

To the present time, all specimens of *Palmerinella palmerae* found in Trinidad belong to *Palmerinella palmerae diminuta*. They show less variation than do the Cuban examples of *Palmerinella palmerae palmerae*. It seems likely that the differences between the two subspecies may be due in large part to the differences in their habitats. From the original description by Bermudez (1934) of the localities in which *Palmerinella palmerae palmerae* is found, it would seem likely that the subspecies is living under conditions where the water, though brackish, is clear. On the other hand, at the type locality of *Palmerinella palmerae diminuta* the water is brackish and extremely turbid.

Occurrence.—Holotype (U.S.N.M. P6493) and paratypes (U.S.N.M. P6494a, b) from sample J.S. 190, north of Monkey Point, west coast of Trinidad, B.W.I. Sample taken in fine black silt from just below low-water mark about 20 feet from the outer edge of a mangrove swamp.

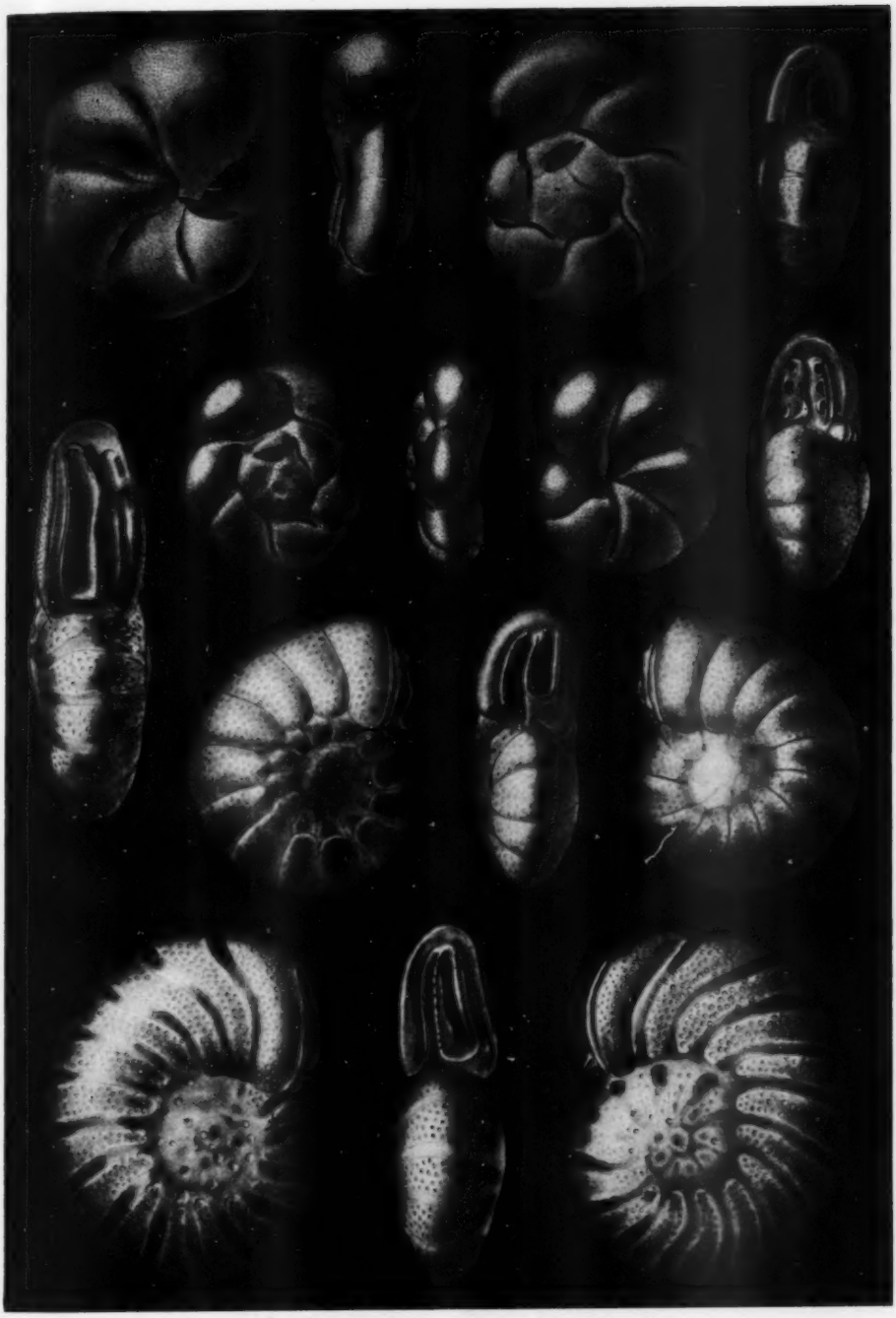
From the San Antonio Bay area of west Texas, Parker, Phleger, and Peirson (1953) figure specimens that compare closely with the Trinidad material.

From Matanzas Bay, Cuba, the author has seen specimens that fall within the subspecies *Palmerinella palmerae diminuta*.

FIGS. 1a–2c.—*Helenia anderseni* (Warren): 1*a*, Spiral view of hypotype (U.S.N.M. P6491) showing the deep folds between the chambers concealing the supplementary sutural apertures; 1*b*, umbilical view showing the deep folds between the chambers concealing the supplementary sutural apertures and the lobe of the last chamber extending across the umbilicus; 1*c*, edge view showing the low arched primary aperture at the base of the final chamber; × 138. 2*a*, spiral view of hypotype (U.S.N.M. P6492); 2*b*, umbilical view; 2*c*, edge view showing clearly the low arched primary aperture at the base of the final chamber; × 138.

FIGS. 3–5c.—*Palmerinella palmerae diminuta* Saunders, n. subsp.: 3, Edge view of paratype (U.S.N.M. P6494a) showing apertural condition in final chamber; × 138. 4, Edge view of paratype (U.S.N.M. P6494b) showing apertural condition in an earlier chamber of the last whorl; supplementary chambers are present between the chambers of the last whorl and the umbilical plug; × 138. 5*a*, Spiral view of holotype (U.S.N.M. P6493) showing early chambers obscured by a semitransparent calcite plug; 5*b*, umbilical view showing series of small supplementary chambers situated between the chambers of the last whorl and the umbilical plug; the prominent lip around the slit like aperture towards the spiral side of the terminal face of the last chamber is well shown; 5*c*, edge view showing paired longitudinal slit like apertures separated by a septum; the continuation of the aperture onto the umbilical side is clearly shown; × 138.

FIGS. 6a–7.—*Palmerinella palmerae palmerae* Bermudez emend. Saunders: 6*a*, Spiral view of lectotype (Cushman Coll. 22707a) showing early chambers visible through a semitransparent calcite plug; 6*b*, umbilical view showing early chambers almost entirely obscured by an umbilical plug; 6*c*, edge view showing pair of apertural slits separated by a septum; the slit toward the spiral side is completely surrounded by a prominent lip while that towards the umbilical side is surrounded by a less prominent lip except at the base where it opens between the last chamber and the umbilical plug; × 105. 7, Edge view of paratype (Cushman Coll. 22707b); the test is broken exposing the terminal face of one of the earlier chambers of the last whorl; the elongate slit apertures are closed by septa through which open linear series of pores; × 105.



FIGS. 1–7.—(For explanation see opposite page).

Fossil examples of the subspecies received from Dr. Bermudez have been collected from the Las Salinas formation of Cuba of questionable Upper Miocene age, from the Pliocene of the Dominican Republic (Jimani formation) and Cuba and from the Pleistocene of Cuba.

Helenia Saunders, n. gen.

Type species.—Pseudoeponides anderseni Warren, 1957.

Test free, trochospiral, spiral side almost flat, umbilical side convex with umbilicus concealed below a lobe of the last chamber. Wall calcareous, perforate. Sutures on both spiral and umbilical sides curved and depressed. Primary aperture an irregular shaped single or multiple opening at the base of the final chamber; in earlier chambers an areal aperture may develop. Supplementary sutural apertures are present on both spiral and umbilical sides; they may be partly or wholly concealed in infolds of the test wall between the chambers. Early whorls of the spiral side show the sutural apertures remaining open.

Remarks.—The species described from Louisiana as *Pseudoeponides anderseni* Warren and which is well developed in Trinidad, is here made the basis of a new genus. In *Pseudoeponides* Uchio the supplementary apertures on the spiral side are placed areally on the chamber surfaces parallel to the sutures. It is possibly significant that *Pseudoeponides* is a marine form while the only known species of *Helenia*, n.gen. is entirely restricted to a brackish water, marsh environment. *Helenia* differs from *Mississippina* Howe in that its supplementary apertures occur along the sutures whereas in the latter genus they are parallel to the equatorial periphery on both spiral and umbilical surfaces. It differs from *Epistomaria* Galloway in that it lacks supplementary chambers on the umbilical side.

The genus is named for Dr. Helen Tappan Loeblich.

Helenia anderseni (Warren)

Figs. 1a–2c

Pseudoeponides anderseni Warren, Contr. Cushman Found. Foram. Res. **8**, pt. 1: 39, pl. 4, figs. 12–15. 1957.

Test small, trochospiral, involute umbilically with a very slightly lobate equatorial periphery; Spiral side almost flat; umbilical side convex with the umbilicus concealed below a lobe of the last chamber. Axial periphery rounded, equatorial periphery slightly lobate. Wall calcareous, fragile, semitransparent, finely perforate. Chambers slightly inflated spirally, more strongly so umbilically; 6 to 7 in the last whorl increasing in size gradually and regularly. Sutures on both spiral and umbilical sides curved, depressed. Primary aperture an irregular shaped single or multiple opening at the base of the final chamber; in earlier chambers a circular areal aperture commonly is developed in the middle of the terminal face. Supplementary sutural apertures are present on both spiral and umbilical sides; they are partly or wholly concealed in infolds of the test wall between the chambers. Early whorls visible on the spiral side show shortened portions of the supplementary apertures remaining open.

Greatest diameter of figured hypotype (U.S.N.M. P6491) 0.34 mm, thickness 0.13 mm, greatest diameter of figured hypotype (U.S.N.M. P6492) 0.25 mm, thickness 0.11 mm. Both hypotypes from sample J.S. 275, Carenage Swamp, west coast of Trinidad, B.W.I.

Remarks.—The Trinidad representatives of this species appear to be identical with those described by Warren (1957) from the coastal marshes of Louisiana.

In Trinidad, *Helenia anderseni* has so far only been found in numbers in the Carenage Swamp where it occurs in association with *Haplophragmoides manilaensis* Anderson, *Siphotrochammina lobata* Saunders, etc., in an inshore brackish water environment. Further notes on this locality may be found in Saunders, 1957, p. 3.

REFERENCES

Bermudez, P. J. *Un genero y especie nueva de foraminiferos vivientes de Cuba.* Mem. Soc. Cubana Hist. Nat. **8**(2): 83–86, figs. 1–3. 1934.

Parker, F. L., Phleger, F. B., and Peirson, J. F. *Ecology of Foraminifera from San Antonio Bay and environs, southwest Texas.* Cushman Found. Foram. Res. Spec. Publ. **2:** 1–75, pls. 1–4. 1953.

Saunders, J. B. *Trochamminidae and certain Lituolidae (Foraminifera) from the Recent brackish-water sediments of Trinidad, B.W.I.* Smithsonian Misc. Coll. **134**(5): 1–16, pls. 1–4. 1957.

Stainforth, R. M., and Stevenson, F. V. *Three new Foraminifera from the Tertiary of Ecuador.* Journ. Pal. **20:** 560–565, pl. 86. 1946.

Warren, A. D. *Foraminifera of the Buras-Scofield Bayou Region, southeast Louisiana.* Contr. Cushman Found. Foram. Res. **8**(1): 29–40, pls. 3, 4. 1957.

ZOOLOGY—*A new* Garibius *from Virginia, with a key to the North American congeners (Chilopoda: Lithobiomorpha: Lithobiidae)*. R. E. CRABILL, JR., Smithsonian Institution.

(Received July 30, 1957)

Garibius is one of the genera of microlithobiids whose center of dispersal seems to be the southeastern United States. Its members are distinguished chiefly by their rather long, thin bodies and long, evenly inflated ultimate legs, which, in the males, bear a low setigerous tibial lobe pierced by a distinct gland canal. In addition, their possession of 20 antennal articles, of 2+2 prosternal teeth, their lack both of produced tergites and divided anterior tarsi, and the absence in most of DPA on leg 15 help to distinguish the known species.

Until recently, no typical[1] member of the genus was known to have more than two dorsal prefemoral spurs on each of the ultimate legs, so that the formula 15D=10200 or 10210 was a convenient feature for easy generic identification. However, collecting in the mountains of southwestern Virginia, Richard L. Hoffman uncovered a new species that places a slightly different complexion upon the genus. The specimen seems typical except for the presence of an anterior dorsal spur upon the ultimate tibia, i.e., 15D=10310. It differs from its congeners in other respects as well. Although the presence or absence of a single spur alone is often not significant, I believe that the presence of one in this case is, chiefly because of the identity and critical position of the spur.

Considering the industry with which Mr. Hoffman has collected the Blacksburg, Va., area for many years without ever bringing to light more than a single specimen of the new species, I suspect it to be quite rare, at least in this particular locality. During the same period and in the same area Mr. Hoffman's efforts have resulted in the accumulation of numerous specimens of *Garibius opicolens* Chamberlin (see discussion), apparently the most common member of the genus.

Following the description below is a key to the known American species of *Garibius*. It is based largely upon the data presented in 1913[2] by R. V. Chamberlin, whose work remains virtually our sole source of information on the majority of the species. The presentation of the data has been altered in some respects to conform with ideas developed from my studies of several of the species, notably *opicolens*.

The examination of the specimens at my disposal has revealed no better criterion for the definition of a species *in Garibius* than plectrotaxy. Dimensions, vestiture, sculpturing, and to a lesser extent size and color seem untrustworthy, whereas the linear dispersions of a number of the spur-series here seem more stable and predictable than they do in various other microlithobiid groups e.g., *Tidabius* and possibly *Sozibius*. Of course this impression, based upon the study of a sizable series referable to *opicolens*, may be quite erroneous. On the basis of this premise, that the plectrotaxic variation observed in my series of *opicolens* is essentially like that of closely-related species, Hoffman's specimen seems sufficiently distinctive to warrant being called new.

One must admit that the relationship of any of these species, including *psychrophilus*, n.sp., and *opicolens*, to the hypothetical biological or polytypic species is not clear at this time; indeed no myriapod has yet been subjected to the scrutiny of modern population systematics. Unfortunately centipedes —especially these centipedes—are so rare in collections that there is very little opportunity for studying variation and particu-

[1] By typical, I refer to those forms whose males are known to have the customary setigerous, tibial lobe on leg 15. On this basis *G. dendrophilus* Chamberlin is excluded, for the examination of scores of adult males has revealed no such lobe. As a matter of fact, there is reason to believe this species is actually the European *Monotarsobius crassipes* (Koch), specimens of which have been intercepted at quarantine in this country upon at least one occasion.

[2] Chamberlin, Bull. Mus. Comp. Zool. **57**(2): 61–80, 1913.

larly distribution effectively, hence to examine these ancient animals as members of evolving, kinetic systems through the eyes of the New Systematics. Therefore we cannot be sure now whether the presently recognized species of *Garibius* are geographical subspecies and interbreeding populations of one or two polytypic species, or whether the genus is a true complex of reproductively-isolated populations. But aside from that, the evidence at hand suggests that at least some of these forms are representative of real populations of some kind and are not merely unique, local variants.

Garibius psychrophilus, n. sp.

Of the known members of the genus only *catawbae* Chamberlin and the new species have a dorsal spur on the fifteenth femur, but in addition *psychrophilus* differs from all of its congeners in possessing an anterior prefemoral spur dorsally on the ultimate leg, i.e., 15D = 10310. At the same time a number of other features suggests its real affinity, not with *catawbae*, but with *georgiae* and *alabamae*, both of Chamberlin. Of these, *georgiae* seems the more closely related to *psychrophilus*, for both are relatively smaller forms, display essentially the same color patterns, lack of coxal armature, and have certain critical spur-series (VPP and VFP) whose anterior limits are displaced quite far to the rear (see the key, 3a and 3b).

Holotype, ♂. Virginia, Montgomery County, Blacksburg, February 1957. Richard L. Hoffman, leg. Deposited in the United States National Museum; Myriapod type number 2382.

Total length: 7.0 mm. Color: tergites and legs 1–13 pale sordid yellow, not fulvous or brownish, without a longitudinal dark streak; cephalic plate, antennae, and legs 14 and 15 deeper yellow, approaching yellowish orange. Antennae: each 2.3 mm long, with 20 articles; setae moderately dense, each long and pale. Cephalic plate: length to greatest width 1:1, each dimension 0.75 mm; surface shiny, impressed with large areolations; marginal interruptions present but very obscure, the lateral flange essentially continuous; each eye-group of three series, i.e., 1 + 4, 3, 2, the single ocellus, the upper serial ocelli, and the Organ of Tömösvary all essentially equal in size. Prosternum: very sparsely clothed with long, pale setae; chitin-lines complete; teeth 2 + 2, a line through their apices so slightly recurved as to appear essentially straight; medial diastema narrow, acute, strictly V-shaped; porodonts setiform, conspicuous, their tips deflected medially. Tergites: sparsely setose; slightly rugose; like the head relatively coarsely areolate; non produced; posterior margins of major tergites either straight or only slightly incised; greatest width of the tenth is 0.75 mm. Legs: anterior tarsi entirely without evidence of division; tarsus 15 without accessory claws, with pretarsus only, pretarsus 14 with only the inner accessory claw, the outer (setiform) accessory not apparent; ventral tarsal vestiture distinctly denser than that of other leg articles; no coxa laterally armed, coxal pores of both right and left sides, 2, 3, 3, 2; legs 15, as usual, very long, excluding the coxa 2.3 mm, legs 14 excluding coxa 1.8 mm long; ultimate tibia 2.33 times longer than greatest width (measured from above), distally with a distinct setose, glandular, dorsomedial lobe, this pierced by a conspicuous, pigmented gland canal.

Plectrotaxy: where C = coxa, T = trochanter, P = prefemur, F = femur, Ti = tibia; and a = anterior, m = medial, p = posterior.

	Dorsal				Ventral			
	C	P	F	Ti	T	P	F	Ti
1		p	a	a			m	m
2		p	ap	a			m	m
3		p	ap	a			am	m
4		p	ap	a			am	m
5		p	ap	a			am	m
6		p	ap	a			am	m
7		p	ap	a			am	m
8		p	ap	ap		p	am	m
9		p	ap	ap		p	am	am
10		p	p	ap		p	am	am
11		mp	p	ap		p	am	am
12	a	mp	p	p		mp	am	am
13	a	mp	p	p		amp	am(p)	am
14	a	mp	p		m	amp	am	
15	a	amp	p		m	amp	am	

CONCERNING GARIBIUS OPICOLENS AND PAGOKETES CHAMBERLIN AND BRANNERI (BOLLMAN)

According to Chamberlin (op. cit., pp. 62, 63), the chief distinction between *pagoketes* and *opicolens* is the presence in the former of two pairs of laterally-armed posterior coxae and of only one pair in the latter. Also, spur-series VTiA begins on leg 2 in Chamberlin's type of *opicolens*, and on 7 in the type of *pagoketes*. My

examination of a series of specimens referable to *opicolens* shows clearly that samples *always* have either one *or* two pairs of coxae laterally armed, so that the significant distinction in *Garibius* seems to be between: 1) specimens *without any* lateral coxal armature (e.g. *georgiae* and *psychrophilus*); and 2) specimens with lateral spurs *at least* on the 15th coxae. In the same material the anterior limit of VTiA was found to vary greatly, from leg 1 through leg 8, so that distinguishing between the two forms on this basis seems meaningless. All available evidence considered, *opicolens* and *pagoketes* appear to be conspecific. Invoking the right of the first reviser, I select *opicolens*, whose full description has page priority, as the senior synonym of *pagoketes*.

It is also likely that both Chamberlin species are referable to an older name, *Lithobius* (= *Garibius*) *branneri* Bollman, which was based upon seven specimens captured at Knoxville, Tennessee. Unfortunately we cannot be positive of this synonymy, for the original description permits no more than a generic assignment, and none of the National Museum's cotypes is sufficiently complete to permit a solution to the problem. Provisionally, then, it seems necessary to regard *branneri* as *species inquirendae*.

KEY TO THE NORTH AMERICAN SPECIES OF GARIBIUS

(1a) DFP present on 15, i.e. 15D=10310 or 10210 2

(2a) 15D=10310. DPM begins approximately on 11. VFP begins approximately on 13. VPP begins approximately on 8. No coxa laterally armed. ..... *psychrophilus*, n.sp.

(2b) 15D=10210. DPM begins on 1–3. VFP begins on 1–3. VPP begins on 1–3. At least coxae 15 laterally armed ..... *catawbae* Chamberlin

(1b) DFP absent on 15, i.e., 15D=10200 3

(3a) VPP begins on 9–13 4

(4a) No coxae laterally armed. DPP begins on 1–3. *georgiae* Chamberlin

(4b) At least coxae 15 laterally armed. DPP begins approximately on 12 ..... *alabamae* Chamberlin

(3b) VPP begins on 1–3 5

(5a) VPF begins approximately on 8 ..... *mississippiensis* Chamberlin

(5b) VFP begins on 1–3 6

(6a) VPA absent on 11 and 12 ..... *opicolens* Chamberlin

(6b) VPA present on 11 and 12 ..... *monticolens* Chamberlin[3]

[3] This may be a valid point of distinction, for one each of my specimens of *opicolens*—of whatever stage of epimorphic development and in adults—VPA begins on 13, never on 11 or 12.

STANDARD MUSICAL PITCH

One of the lesser known services of the National Bureau of Standards is the broadcasting of a musical tone of standard pitch—middle "A" at 440 cycles per second—over its shortwave stations WWV (Beltsville, Md.) and WWVH (Maui, Hawaii). These broadcasts make standard pitch available day and night throughout the United States and over much of the world. Since a shortwave receiver is all that is needed, easy access to standard pitch is thus provided for piano tuners and amateur and professional musicians, as well as for makers of musical instruments.

A 600-c/s tone is also broadcast. This, together with the 440-c/s tone, is used by scientists, electronics engineers, and manufacturers in the measurement of short intervals of time and for calibrating instruments and devices that operate in the audio and ultrasonic frequency ranges. Both the 440- and the 600-c/s tones are obtained from an electronic, crystal-controlled oscillator and are accurate, as transmitted, to better than 1 part in 100,000,000.

The two frequencies are broadcast alternately, starting with 600 c/s on the hour for 3 minutes, interrupted 2 minutes, followed by 440 c/s for 3 minutes and interrupted 2 minutes. Each 10-minute period is the same except that WWV is off the air for 4 minutes beginning at 45 minutes after each hour; and WWVH is silent, in addition, for a 34-minute period each day beginning at 1900 Universal Time (9 a.m. in Hawaii or 2 p.m. E. S. T.).

To provide greater assurance of reliable reception, transmissions from the NBS stations are made simultaneously on several standard broadcast frequencies. WWV broadcasts on 2.5, 5, 10, 15, 20, and 25 Mc (megacycles per second) and WWVH broadcasts on 5, 10, and 15 Mc.

In this country, A = 440 c/s has been accepted as standard pitch since 1925. Initially, this value

was agreed upon by the Music Industries Chamber of Commerce as a useful compromise among the various pitches chosen arbitrarily by different musical groups. In 1936 the same pitch standard was adopted by the American Standards Association giving it the status of an industrial standard. Three years later the International Federation of the National Standardizing Associations (ISA)[1] sponsored a conference in London. France, Germany, Great Britain, Holland, and Italy sent delegates, and the United States and Switzerland sent official messages. Six of the seven countries independently proposed A = 440 as the standard and the conference adopted it unanimously. The same standard was again endorsed by the International Organization for Standardization (ISO) in 1953; and was accepted as an ISO Recommendation in 1955.

The National Bureau of Standards maintains the A = 440 standard as the one on which general agreement has been reached. The musical merits of any particular standard are, of course, outside its province.

EARLIER PITCH STANDARDS

Previous standards of pitch[2] were defined in terms of the frequency of a particular tuning fork or bar, or the length of a specified vibrating air column (organ pipe). Since the sound frequencies generated by these devices vary with the surrounding temperature, it is necessary to specify the temperature at which comparisons with these standards should be made.

In 1859 the "Diapason Normal" was defined in terms of a standard tuning fork deposited by the French Government at the Paris Conservatory of Music. The vibration frequency of this fork was stated to be 435 c/s when measured at the then standard laboratory temperature of 15°C. When R. Koenig (1880) made a careful determination of the frequency, it proved to be 435.45 c/s at 15°C and to have a thermal coefficient of −0.0486 c/s per degree Centigrade. Thus the fork would really have the defined standard frequency at slightly over 24°C.

An international congress in Vienna in 1891 adopted the French definition of the Diapason Normal, and it acquired the name of "International Pitch." Great Britain and the United States apparently did not attend this meeting, though A = 435 was used as a standard by a number of musical groups and instrument makers in this country after its adoption by the Vienna congress.

In many places the pitch standards in actual use were strongly influenced by the way large, permanently installed pipe organs were tuned. Yet, of all the mechanical devices used to generate musical frequencies, the vibrating air column of the pipe organ is the most sensitive to changes in temperature. Their frequency would therefore depend on what the temperature happened to be when they were adjusted to conform to the standard fork in the Conservatory at Paris. Since the advent of better heating systems and air conditioning, the temperature at which most musical instruments are used today (in the United States, at least) is better represented by 20°C (68°F) than by the temperature of 15°C (59°F) associated with the Diapason Normal. Luckily, an organ pipe tuned to A = 435 at 15°C will actually be tuned almost exactly to A = 440 at 20°C.

ADVANTAGES OF PRESENT STANDARD

From a technical point of view, the present standard of musical pitch, as maintained by the Bureau, has the advantage that it is free from the vagaries of the material objects (tuning forks, organ pipes) that embodied past standards. Thanks to modern electronic techniques for generating and stabilizing oscillations, a tone is produced that for all practical purposes is independent of the temperature of the surroundings.

This would apply, of course, to any musical frequency that might be chosen. It happens, however, that the 440-c/s frequency stands in a very simple relation to other frequency standards maintained by the Bureau and can therefore be produced with a minimum of additional equipment. A tone of 435 c/s for example, would require a somewhat more complicated technical arrangement.

In changing over to Standard Pitch, little or no alteration is necessary in adjusting instruments tuned to the older standard. Instruments tuned by string tension and the open vibrating air columns of pipe organs present no problems at all. Woodwinds can be corrected partly by the tuning adjustment of the instrument and partly by the breath control of the player; and changes required in the reed stops of the organ are within the range of the instrument's tuning adjustments.

[1] This has now been superseded by the International Organization for Standardization (ISO).

[2] A history of earlier standards of pitch is appended to the English translation of Sensations of Tone, by Helmholtz, translated by A. Ellis, published by Longmans, Green & Co., New York, 1895 (reprinted by Dover, New York, 1957). A history of British standards of pitch is given in the folder *British concert pitch*, published by British Standards Institution, 28 Victoria Street, London S. W. I.

ZOOLOGY.—*Additional records of Western Atlantic octocorals.*

FREDERICK M. BAYER, U. S. National Museum.

(Received April 23, 1957)

Since the publication of my paper recording a number of species of Octocorallia from the Gulf of Mexico (1952), several additions and corrections have come to light, thanks chiefly to the work of the U. S. Fish and Wildlife Service m/v *Oregon* and the interest of Stewart Springer and Harvey Bullis. I take this opportunity to place this information on record.

Exploratory trawlings upon the shrimp grounds in the Gulf of Mexico have yielded several interesting sea-pens, a group not well known in the Gulf of Mexico. These are described and figured below, together with a list of new records of Gorgonacea.

Order PENNATULACEA

Family PROTOPTILIDAE

Protoptilum thomsonii Kölliker

Fig. 1b

Protoptilum Thomsonii Kölliker, Abh. Senckenb. Naturf. Ges. **8:** 195, pl. 24, figs. 220–222. 1872.
Protoptilum thomsoni Jungersen, *Ingolf*-Exped. **5** (1): 52, pl. 1, figs. 4–8 (Danish ed.). 1904.
Protoptilum thomsoni Bayer, Journ. Washington Acad. Sci. **42:** 189. 1952.

The specimens before me agree with Kölliker's description in all essentials except size, and they are in excellent conformity with Jungersen's later description and figures. They do not, however, agree with the key characterization given by Deichmann (1936, p. 264: "anthocodia with no spicules in the body wall") which, furthermore, is in contradiction to Jungersen's description.

The largest specimen is basally incomplete, lacking stalk entirely. The part preserved is 30.5 cm in length, with nearly round, naked axis 3 mm in diameter projecting another 1 cm. The distal tip is recurved just as shown by Jungersen. The rhachis has a maximum diameter of 6–7 mm; the autozooids occur in 3 irregular rows on each side of the rhachis and are further oriented in more or less transverse or oblique rows. The adherent, apically directed calyces show only a vague suggestion of 2 or 3 marginal teeth. The autozooids are exsert and have spicules in bands on the 3 abaxial tentacles, extending downward on the body wall between the septa. Except for a dorsal track about 2 mm wide, the entire surface of the rhachis between the autozooid calyces is occupied with siphonozooids. Near the naked dorsal track the siphonozooids are arranged in quincunxial order between the autozooid calyces, but opposite them the siphonozooids are crowded and irregularly distributed. The colony is very pale flesh-color, the colored spicules being only faintly pink.

The other specimens collected by the *Oregon* agree with the above in all significant features. All are fragmentary, lacking both apex and stalk. They are of smaller size than the specimen described, the smallest having a major diameter of about 3 mm. The autozooids show some variation in spiculation, some specimens having the rows of needles in the tentacles extending down the body wall between the septa either as narrow bands or spreading out to cover the body wall completely. All 8 tentacles may have strong spiculation. Many of the spicules in the autozooid calyces and rhachis are pink or red, imparting an over-all reddish color to the colonies.

Fragments of *Protoptilum* were obtained at two stations off Puerto Rico by the Johnson-Smithsonian Deepsea Expedition. They are too small to be determined with any great assurance but probably represent *P. thomsonii*.

Type locality.—North Atlantic, lat. 36° 37′ N., long. 7° 38′ W., 322 fathoms; *Porcupine* Expedition, 1869.

Records.—Gulf of Mexico, off Alabama and Louisiana (Bayer, 1952). Now reported off the coast of Texas: 27° 01.4′ N., 96° 16.8′ W., 200–280 fathoms, *Oregon* station 548, April 8, 1952; also 27° 03′ N., 96° 16′ W., 210 fathoms, *Oregon* station 1093, June 4, 1954.

Family VIRGULARIIDAE

Virgularia presbytes Bayer

Virgularia mirabilis Bayer, Journ. Washington Acad. Sci. **42:** 189. 1952.
Virgularia presbytes Bayer, Journ. Washington Acad. Sci. **45:** 295, figs. 1, 2a–3e. 1955.

This species has been previously recorded from localities from Corpus Christi, Tex., to

Mobile, Ala., and from the east coast of Florida north of Cape Canaveral. Since 1955 it has been collected at the following additional localities: Off Jacksonville, Fla., 30° 13′ N., 80° 41′ W., 15–16 fathoms, *Pelican* station 33, April 23, 1956; off Jacksonville, Fla., 30° 04′ N., 80° 23′ W., 25 fathoms, *Bowers* station 30, March 9, 1956; south of Cape Fear, N. C., 33° 19′ N., 78° 07′ W., 17 fathoms, *Bowers* station 59, March 17, 1956.

The specimens from the above localities are in full accord with the description published in 1955.

The distribution of this species in the northern Gulf of Mexico and along the Atlantic coast conforms with what I have called the "Carolin-

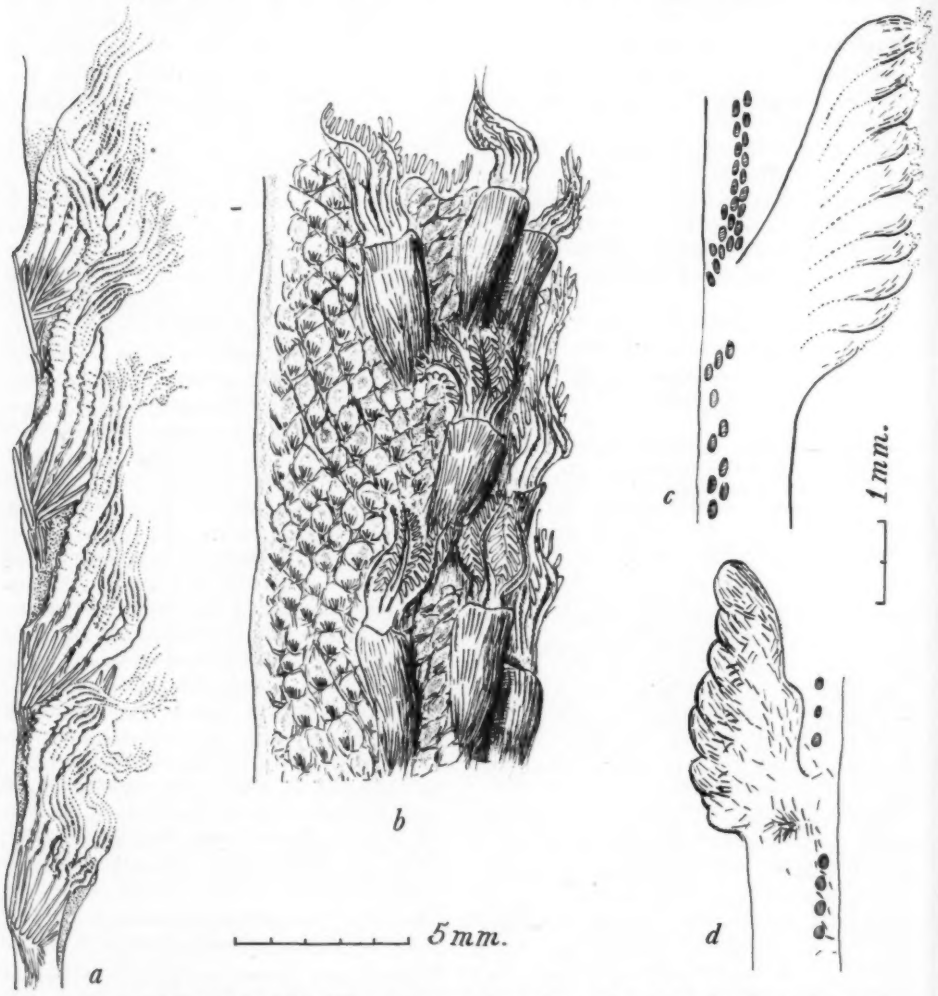


FIG. 1.—*a*, *Stylatula elegans* (Danielssen), lateral view showing four polyp-leaves; *b*, *Protoptilum thomsonii* Kölliker, lateral view of part of rhachis showing distribution of siphonozooids and autozooids; *c*, *Acanthoptilum oligacis*, n. sp., polyp-leaf and adjacent rhachis showing arrangement of siphonozooids and distribution of spicules in autozooids; *d*, *Acanthoptilum agassizii* Kölliker, polyp-leaf and adjacent rhachis showing arrangement of siphonozooids and distribution of spicules in autozooids. (5-mm scale applies to *a* and *b*; 1-mm scale to *c–d*.)

ian" pattern. If the fossil specimens from the Tertiary of Trinidad are specifically identical, as I have suggested, the species was formerly distributed more widely than present records indicate. Such may prove still to be the case when careful collecting is done in the West Indies.

Stylatula antillarum Kölliker

Stylatula antillarum Kölliker, Abh. Senckenb. Naturf. Ges. **7:** 568. 1872.

Kölliker's type, from the Paris Museum, had 9 leaves in 20 mm of rhachis; at least 26 polyps (autozooids) in each leaf, arranged in a single row; calyces 0.24–0.30 mm broad, containing calcareous needles; a spicular plate (beneath the leaves) containing 7 or 8 large needles, smaller than in *S. darwinii* but still well developed. The sizes of spicules from various regions of the type are given in the table below, compared with measurements of spicules from specimens taken in the Gulf of Mexico by the *Oregon*.

	Kölliker's type		*Oregon* specimens	
	Length (mm)	Width (mm)	Length (mm)	Width (mm)
Large needles of spicular plate	1.8–2.4	0.12–0.20	1.8–2.0	0.25–0.30
Smaller needles of spicular plate	0.44–0.60	0.055–0.066	0.6–1.0	0.035–0.06
Needles of autozooid calyces	0.11–0.13	0.011–0.016	0.17–0.25	0.015

The present specimens are referable to *Stylatula antillarum* but differ from Kölliker's material in some regards. The specimens before me have only 4–6 leaves in 20 mm of rhachis (compared with 9 in the type). There are 8–12 large needles in the spicular plate, more numerous and stouter than in the type. The smaller needles of the plate and those of the calyces and tentacles also are somewhat larger. The tentacles are filled with small needles, which extend into the pinnules.

Neither of the species of *Stylatula* with widely spaced leaves (*elegans* and *brasiliensis*) has so many polyps in each leaf. Of the species with needles in the tentacles, only *S. lacazii* and *S. antillarum* have as high a number of polyps in the leaves as the present specimens. The spicular plate of *S. lacazii* is much weaker than in the material now under consideration, which consequently agrees most closely with *Stylatula antillarum*. When numerous specimens from several West Indian and South American localities are available for a study of individual and geographical variation, the status of the various described species may be clarified.

Type locality.—"Antilles" (Paris Museum).

Records.—Off Cape San Blas, Fla.: 29° 30.9′ N., 86° 10.6′ W., 55 fathoms; *Oregon* station 604, July 12, 1952. Off Mississippi Delta: 28° 55′ W., 100 fathoms; *Oregon* station 1421, September 23, 1955.

Stylatula elegans (Danielssen)

Fig. 1a

Virgularia elegans Danielssen, Forh. Vid. Selsk. Christiania (1859): 277. 1860.

Stylatula elegans Deichmann, Mem. Mus. Comp. Zool. **53:** 270. 1936.

A number of fragmentary specimens, mostly 10–12 cm in length and lacking both apex and stalk, were taken in 180 fathoms off Cape Canaveral, Fla., by the *Pelican*.

The polyp-leaves are openly spaced and regularly paired, 3 or 4 pairs in 2 cm of rhachis; a conspicuous spicular fan containing 10–12 large needles supports each leaf. The leaves consist of 3–7 large, well-separated autozooids. In each leaf the autozooid nearest the naked dorsal tract is longest, as much as 7 mm long in preserved material. A band of needles occurs in the tentacle backs and for some distance down the polyp body. In the proximal part of the leaves, where the autozooids are fused together, conspicuous bands of spicules follow the lines of fusion between the autozooids and merge with the spicules of the supporting fan. The siphonozooids occur laterally on the rhachis in triangular clusters above each polyp-leaf (i.e., in the axils) and are thus hidden from view.

The features noted above agree well with Kölliker's description of the species except for the somewhat larger number of needles in the supporting fan or plate, and the presence of spicules on the polyp-bodies. Deichmann (1936, p. 270) does not mention spicules in the polyp-bodies, but notes about ten needles in the supporting fan. A specimen dredged south of Cape Fear by the *Albatross* has spicules in the polyp-bodies, but another, from off Chesapeake Bay, lacks them. Specimens from Japan lack the body spicules and consequently agree precisely with the typical form.

Type locality.—Off Molde, Norway, 25–50 meters.

Records.—West Atlantic. Off Cape Canaveral, Fla.: 28° 22′ N., 79° 53′ W., 180 fathoms; *Pelican* station 13, March 11, 1956. South of Cape Fear, N. C.: 32° 53′ 00″ N., 77° 53′ 00″ W., 99 fathoms; *Albatross* station 2313, January 5, 1885. Off Chesapeake Bay: 37° 59′ 30″ N., 73° 48′ 40″ W., 444 fathoms, *Albatross* station 2171, July 20, 1884.

East Pacific. Entrance to Port Heda, Honshu, North 49°, east 1.9 miles, 161–167 fathoms; *Albatross* station 3737, May 17, 1900. (Not recorded from Japan by Balss, 1910, or by Nutting, 1912.)

Genus **Acanthoptilum** Kölliker

The genus *Acanthoptilum* includes long, slender sea-pens with well-formed polyp-leaves consisting of completely or mostly fused autozooids decreasing in length dorsoventrally; siphonozooids in single or multiple rows on each side of the dorsal tract, between the autozooid leaves. Spiculation weak to moderate, in the form of needles and, in some species, biscuit-shaped platelets. In most species a cluster of needles at the base of each leaf represents the supporting fan or spicular plate found in the allied genus *Stylatula*.

Two species of *Acanthoptilum* are described from the western Atlantic, namely, *A. pourtalesii* Kölliker and *A. agassizii* Kölliker. The latter of these is represented in the *Oregon* collection. Also present is a specimen of *Acanthoptilum* that differs in specific characters from both described species and which must, at least for the present, be considered as a third western Atlantic species.

Type species.—*Acanthoptilum pourtalesii* Kölliker, by subsequent designation, Kükenthal, 1915.

Acanthoptilum agassizii Kölliker

Fig. 1d

Acanthoptilum agassizii Kölliker, Abh. Senckenb. Naturf. Ges. 7: 572, pl. 18, fig. 156; pl. 19, fig. 157. 1872.

Five specimens dredged off Pensacola, Fla., agree in the main with Kölliker's original description. Discrepancies are attributable to the larger size of the present material. They range in length from 20 to 38 cm, compared with 17.5 cm in Kölliker's specimen. The maximum length of the leaves is about 4 mm, width at base about 1 mm; autozooids 7. In the smallest specimen the leaves are about 2.5 mm long and have only 5 autozooids. The polyp-leaves of all the specimens are conspicuously but moderately spiculate. Abundant needles are longitudinally disposed in the calycular part of the autozooids, somewhat less numerous in the leaf proper; spicules are more numerous along the dorsal edge of the leaves; at the base of the leaves is a clump of needles representing the spicular plate. No biscuit-shaped sclerites are present. The siphonozooids occur below each leaf in a single row along the dorsal side of the rhachis. A few small needles occur in the vicinity of the siphonozooids, but not to the extent reported by Kölliker.

Type locality.—Off Carysfort Reef, Fla., 35 fathoms; L. F. de Pourtalès, March 21, 1869.

Records.—Off Pensacola, Fla.: 29° 41′ N., 87° 11′ W., 100 fathoms; *Oregon* station 1558, June 21, 1956.

Acanthoptilum oligacis, n. sp.

Fig. 1e

A large specimen, broken in two places and missing a small part of the proximal end, measures 111 cm in length. The fully formed polyp-leaves are 4–5 mm long, alternating on the rhachis, 4–5 mm apart (closest basally and apically). Leaves consisting of 10 autozooids almost completely fused. Spiculation weak, consisting of a few needles longitudinally disposed in the calycular part of the autozooids. No spicules in the middle and basal parts of the leaves; no trace of a basal cluster of needles. Siphonozooids in a double row on each side of the dorsal tract, between the leaves; immediately above each leaf the rows may irregularly increase to 3. In the rhachis there are slightly constricted, slipper- or biscuit-shaped platelets very sparsely distributed. Axis round, white, smooth.

Holotype.—U.S.N.M. 50561: Gulf of Mexico, off Mississippi Delta: 28° 17′ N., 89° 55′ W., 100 fathoms; *Oregon* station 1421, September 23, 1955.

Remarks.—The type of *A. oligacis*, n. sp. much resembles the specimens of *A. agassizii* just described but is a great deal larger. It is characterized by the generally weak spiculation and complete absence of the clumps of needles in the leaf bases, and siphonozooids in double rows. *A. pourtalesii*, which has its siphonozooids

in double rows, has strong groups of needles that form a good supporting fan below each leaf, and only 5 or 6 autozooids in the leaves.

Order GORGONACEA

Family ANTHOTHELIDAE

Anthopodium rubens Verrill

Gulf of Mexico: East Bank, 30 miles off Freeport, Tex. Collected by divers in about 5 fathoms depth, June 4, 1956. Received from Robert H. Parker and Willis G. Hewatt. This is a new record for the Gulf of Mexico and represents the rediscovery of a species "lost" for 84 years. It will be redescribed in detail in a subsequent paper.

Family ACANTHOGORGIIDAE

Acanthogorgia schrammi (Duchassaing and Michelotti)

Gulf of Mexico: Campeche Bank, west of Yucatán Peninsula: 21° 17′ N., 91° 18′ W., 20 fathoms (exceptionally shallow); *Oregon* station 1048, May 13, 1954. East of Mississippi Delta: 29° 06′ N., 88° 19′ W., 260 fathoms; *Oregon* station 1283, March 13, 1955.

Family PARAMURICEIDAE

Bebryce grandis Deichmann

Gulf of Mexico: West of Cape San Blas, Fla.: 29° 30.9′ N., 86° 10.6′ W., 55 fathoms; *Oregon* station 604, July 12, 1952. South of Galveston, Tex.: 27° 57.4′ N., 94° 54′ W., 50 fathoms; *Oregon* station 539, April 16, 1952.

Echinomuricea atlantica (Johnson)

Fig. 2

Gulf of Mexico: Off Pensacola, Fla.: 29° 41′ N., 87° 11′ W., 100 fathoms; *Oregon* station 1558, June 21, 1956.

Placogorgia mirabilis Deichmann

Gulf of Mexico: South of Cape San Blas, Fla.: 28° 55′ N., 85° 07′ W., 29 fathoms; *Oregon* station 892, March 7, 1954.

Straits of Florida. NW. of Cay Sal Bank: 24° 03′ N., 80° 30′ W., 150 fathoms; *Oregon* station 1349, July 1955.

Scleracis guadalupensis (Duchassaing and Michelotti)

Gulf of Mexico: South of Cape San Blas, Fla.: 28° 50′ N., 85° 00′ W., 28 fathoms; *Oregon* station 897, March 7, 1954. South of Mobile, Alabama: 29° 26′ N., 87° 33′ W., 41–42 fathoms; *Oregon* station 793, June 9, 1953.

Swiftia exserta (Ellis and Solander)

Gulf of Mexico: Off Sarasota, Fla., Robert H. Stewart. [Haul b-170.]

Thesea grandiflora grandiflora Deichmann

Gulf of Mexico: West of Cape San Blas, Fla.: 29° 30.9′ N., 86° 10.6′ W., 55 fathoms; *Oregon* station 604, July 12, 1952.

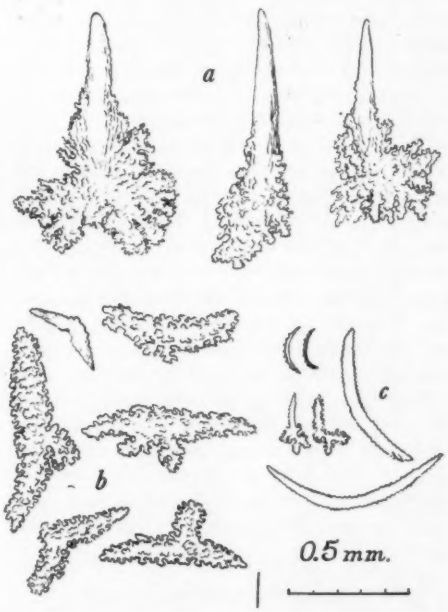


FIG. 2.—*Echinomuricea atlantica* (Johnson): Spicules of: *a*, Calyx walls; *b*, cortex; *c*, anthocodia. (All figures at same magnification.)

Thesea grandiflora rugulosa Deichmann

Gulf of Mexico: West of Cape San Blas, Fla.: 29° 30.9′ N., 86° 10.6′ W., 55 fathoms, *Oregon* station 604, July 12, 1952.

Thesea hebes Deichmann

Straits of Yucatán: NE. of Cape Catoche, Yucatán: 22° 40.2′ N., 86° 36.6′ W., 206 fathoms; *Oregon* station 590, April 19, 1950.

Thesea plana Deichmann

Gulf of Mexico: South of Cape San Blas, Fla.: 28° 55′ N., 85° 07′ W., 29 fathoms; *Oregon* station 892, March 7, 1954.

Genus **Trachymuricea** Deichmann

The genus *Trachymuricea* was established by E. Deichmann (1936:132) to include Pourtalès' *Acanthogorgia hirta* (type species) and Broch's *Paramuricea kükenthali*. The type species is known from Bahia Honda, Florida Keys, and is recorded from *Blake* stations 166 and 176 off Barbados, although the latter specimens are lost. *Paramuricea kükenthali* Broch was originally recorded from the lower littoral and upper abyssal of Trondhjemsfjord, Norway, and later by Aurivillius (1931) from the same locality, in 100–250 meters and 300–350 meters.

The rind sclerites with a conical or pyramidal central process are very similar in form to the spicules of *Villogorgia*, which, however, regularly have 4 rootlike projections. The calycular sclerites are fusiform, longitudinally placed, with a slanting, laciniated projection, whereas in *Villogorgia* they have several spreading root processes that make the spicules wider than long. *Trachymuricea* differs from *Paramuricea* in its large number of collaret and opercular spicules.

Specimens agreeing in every particular with Broch's original description of *Paramuricea kükenthali* have recently been collected in the Gulf of Mexico by the *Oregon*. They are perfectly distinct from the type species, and I give below a brief description and figures of the spicules.

Trachymuricea kükenthali (Broch)

Fig. 3

Colonies much broken. Branching irregular, lateral, but mostly in one plane, straggling. Largest stems about 5 mm in diameter, end twigs 3 mm. Axis woody, rather fragile because of the abundant loculation of the cortex and unusually wide, soft medula. Coenechyme thin, with a thin inner layer and a thicker outer layer; outer layer containing irregularly fusiform sclerites, many of them with a single, central, prickly, pyramidal process. The inner layer is poor in spicules, none of which have the central process. The calyces are about 1.5 mm tall; with the contacted anthocodiae, 3–4 mm. They are widely separated, irregularly scattered, and more numerous at the twig tips which therefore appear somewhat clavate. The calycular walls contain fusiform sclerites with a terminal or subterminal, slanting projection. The anthocodiae have numerous rows of curved, transversely placed spindles in the collaret, and many bent "hockey-stick" rods *en chevron* in each tentacle base. Alternating with the 8 opercular segments are 8 rows of small rods lying along the septal insertions.

Type locality.—Trondhjemsfjord, Norway; in lower littoral and upper abyssal.

Record.—Gulf of Mexico. Off Mississippi Delta: 29° 06′ N., 88° 19′ W., 260 fathoms; *Oregon* station 1283, March 13, 1955.

Color in life.—"Hell rosa" (Broch); no record of the life colors of the specimens from *Oregon* station 1283.

Remarks.—The bottom temperature was 50.7°F. Collected at the same time were *Acanthogorgia schrammi* (Duchassaing and Michelotti) and a large, arborescent antipatharian.

Trachymuricea hirta (Pourtalès)

Gulf of Mexico: South of Cape San Blas, Fla.: 28° 55′ N., 85° 07′ W., 29 fathoms; *Oregon* station 892, March 7, 1954. This species differs from *T. kükenthali* (Broch) in its more slender branches, smaller calyces, and rougher projecting processes of rind and calyx sclerites.

Villogorgia nigrescens Duchassaing and Michelotti

Gulf of Mexico: West of Cape San Blas, Fla.: 29° 30.9′ N., 86° 10.6′ W., 55 fathoms; *Oregon* station 604, July 19, 1952.

Family Ellisellidae

I have already discussed the nomenclatural difficulties of the "Gorgonellidae" (1955) and altered the familial designation to Ellisellidae. The West Indian representatives of this family belong to the genera *Ellisella* (=*Scirpearia* of many authors) *Nicella*, and *Riisea*. The genus *Junceella* has been reported from the area (Duchassaing and Michelotti; Wright and Studer; Toeplitz) but probably in error. A specimen reported below (*Ellisella grandis*) suggests a possible source of this error.

There is probably no family of Gorgonacea

more sharply defined than the Ellisellidae or one whose species are more difficult to recognize. It is therefore insufficient to offer locality records for any particular species without a documentary basis for the identification. Deichmann's monograph (1936) illustrates the spicules of the species known from the Western Atlantic and forms the basis for the present determinations. The spicules illustrating the species reported herein are drawn at the same magnification used by Miss Deichmann, so as to facilitate direct comparison of my drawings with hers.

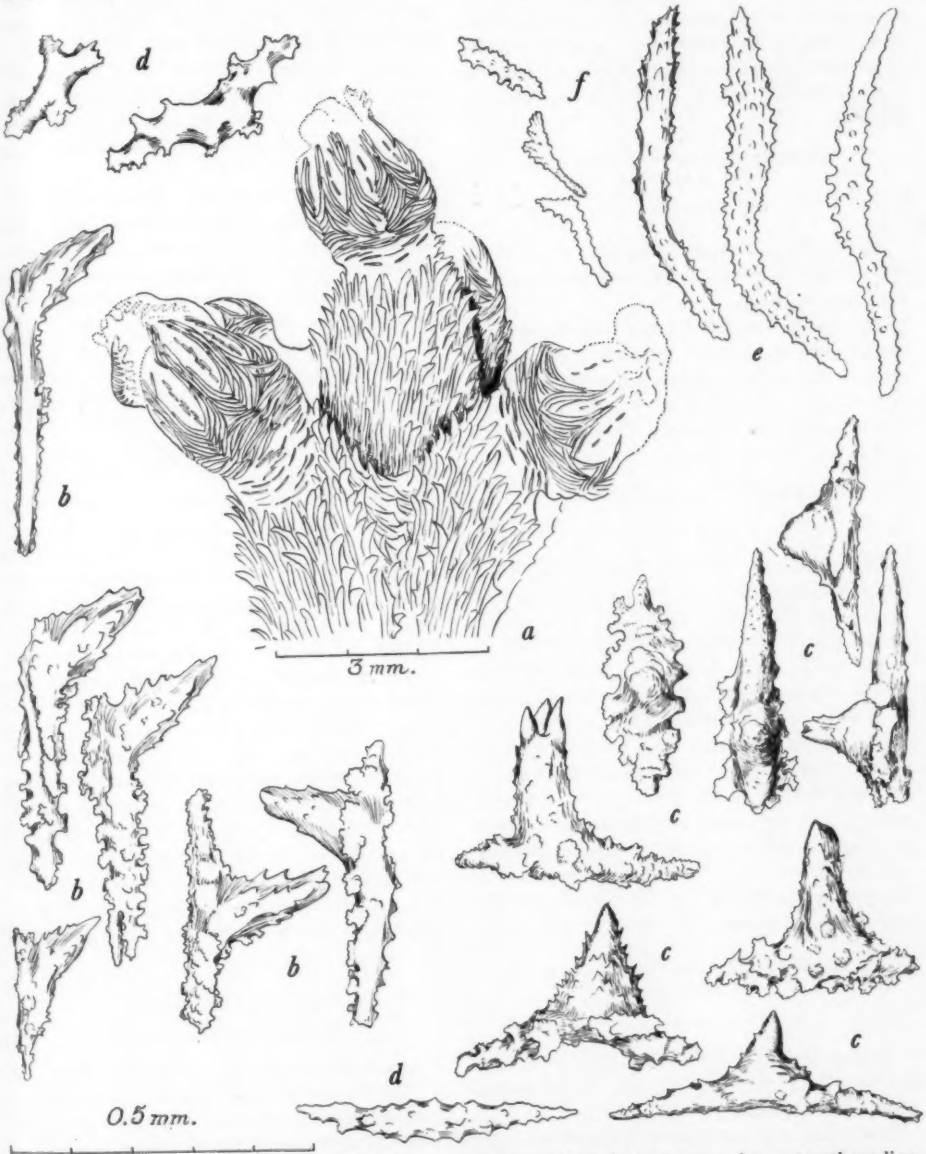


FIG. 3.—*Trachymuricea kükenthali* (Broch): *a*, Tip of branch showing calyces and exsert anthocodiae; *b*, asymmetrical calycular thora-scales; *c*, thorn-scales of stem rind; *d*, simple spindle and irregular bodies of inner cortex; *e*, spicules of operculum; *f*, spicules of tentacles. (0.5-mm scale applies to *b–f*.)

Ellisella atlantica (Toeplitz)

Fig. 4a

Gulf of Mexico: South of Terrebonne Bay, La.: 28° 06′ N., 91° 02′ W., 29 fathoms; *Oregon* station 1416, September 21, 1955.

The calyces are prominent, irregularly biserial, more or less upturned. Color (in alcohol) dark orange with yellowish or whitish calyces, as reported by Deichmann; spicules in agreement with her figures (1936:206, pl. 24, figs. 20–28a).

Ellisella barbadensis (Duchassaing and Michelotti)

Fig. 4b

Gulf of Mexico: South of Mobile, Ala.: 29° 26′ N., 87° 33′ W., 41–42 fathoms; *Oregon* station 793, June 9, 1953.

The calyces are 1.5–2.0 mm tall, biserial, upturned, and more or less appressed. Color (dry) orange, the calyces slightly paler than the surface of the rind. Spicules in agreement with Deichmann's illustrations (1936:208, pl. 24, figs. 1–19).

Ellisella elongata (Pallas)

Fig. 4e–f

Gulf of Mexico: Off Fort Walton, Fla., 13–14 fathoms; Frank Lyman, June 3–4, 1947. West of Cape San Blas, Fla.: 29° 33′ N., 86° 13.2′ W., 60 fathoms; *Oregon* station 603, July 12, 1952.

The two colonies from the northern Gulf of Mexico are identical both in external form and in details of spiculation. They are branched several times near the base, sending up long, nearly straight, rather stiff branches. The calyces are placed in lateral bands of 2 or 3, usually retracted as low mounds. The spicules are in good agreement with Deichmann's illustration, but the double clubs are slightly larger than in her specimens (1936:212, p. 24, figs. 46–48). The rind is reddish orange, the calyces yellow.

Ellisella funiculina (Duchassaing and Michelotti)

Fig. 4g

Gulf of Mexico: South of Pensacola, Fla.: 29° 41′ N., 87° 11′ W., 100 fathoms; *Oregon* station 1558, June 21, 1956.

The colonies are slender, with cylindrical calyces placed biserially. Color (in alcohol) white. Spicules in agreement with Deichmann's illustration (1936:210, pl. 24, figs. 29–36).

Ellisella grandis (Verrill)

Fig. 4c–d

Caribbean Sea: South east of Jamaica: 17° 44′ 05″ N., 75° 39′ 00″ W., 23 fathoms; *Albatross* station 2138, February 29, 1883.

Lesser Antilles: Barbados: Cable station east, south by east, Paynes Bay Church northeast, offshore ¾ mile; 35–75 fathoms, sand and rock; University of Iowa Barbados-Antigua Expedition station 78, June 3, 1918.

Two records extend the known range considerably southward into the West Indies. The specimen from *Albatross* station 2138 is incomplete, consisting of a large branch with two bifurcations. The calyces are placed in 2 or 3 rows along the two sides of the branches; in the lower part of the specimen they are tall and tubular, but toward the end of one of the branches they are contracted to low hillocks. The spicules (Fig. 4, c) are in close agreement with the figures given by Deichmann (1936:214, pl. 24, figs. 42–45). The specimen from Barbados consists of three fragments, including the base, of an apparently unbranched young colony; the calyces are contracted to low warts throughout. Its spicules (Fig. 4, d) are consistently assymmetrical, a tendency noted in this species by Deichmann, but otherwise like those of the type. Wright and Studer's *Juncella barbadensis* could have been such a specimen of *E. grandis*. The colonies are very similar in appearance to those of *E. elongata*, with a tendency to branch several times, producing long, straight end-branches; the color is dark orange-red with yellow calyces. Miss Deichmann has already suggested that *E. grandis* might be a synonym of *E. elongata*, but has noted that the calycular rods of the former seem always to be longer than those of *elongata*. This feature is noted also in the present material, which indicates that the two forms should be maintained separately.

Family CHRYSOGORGIIDAE

Radicipes gracilis (Verrill)

Nicholas Channel: SE. of Cay Sal Bank: 22° 55′ N., 79° 16′ W., 240 fathoms; *Oregon* station 1341, July 1955. There are a number of records in the U. S. National Museum from localities off Georges Bank, Nantucket, and Block Island in

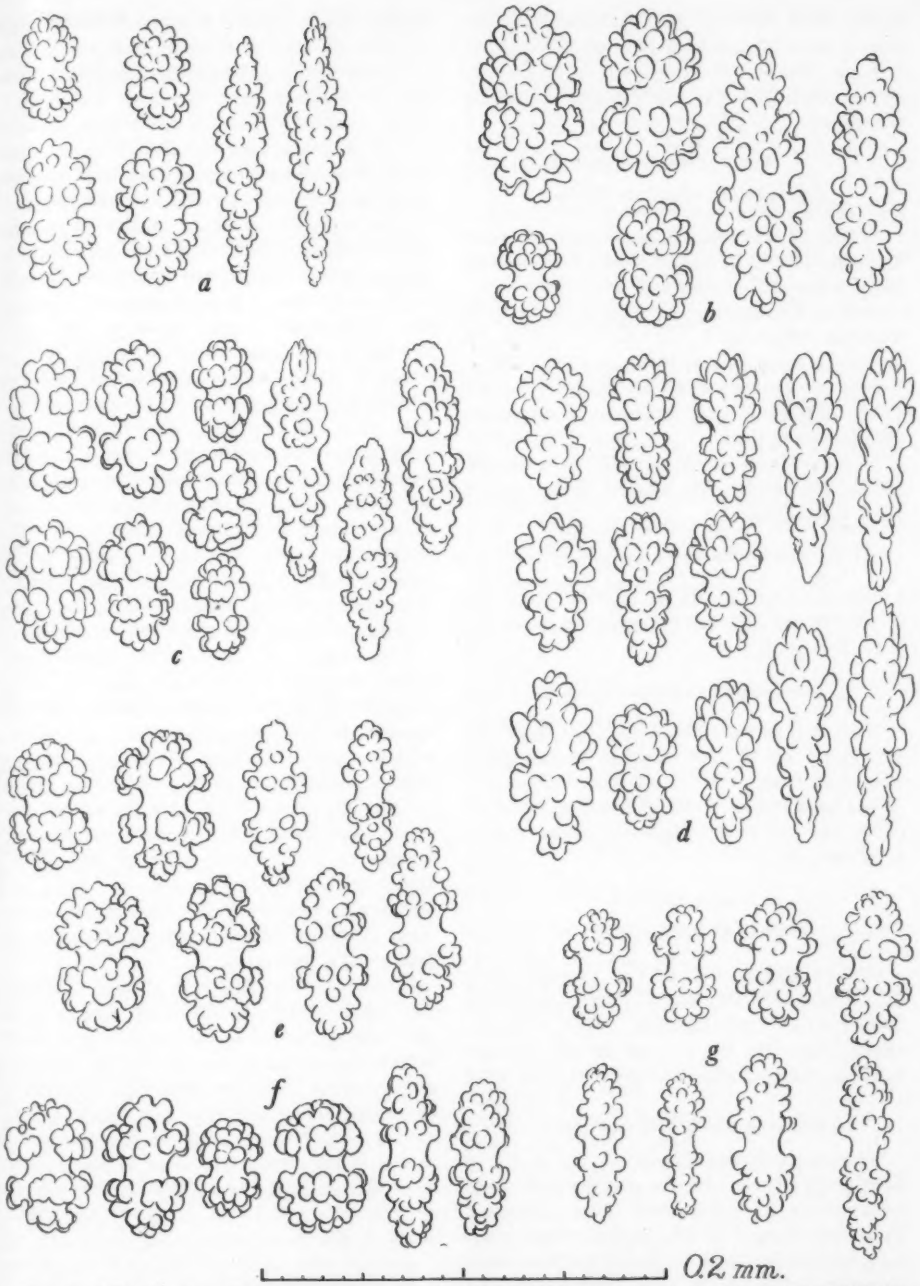


FIG. 4.—Spicules of: *a*, *Ellisella atlantica* (Toeplitz); *b*, *Ellisella barbadensis* (Duchassaing and Michelotti); *c*, *Ellisella grandis* (Verrill); *d*, *Ellisella grandis* (Verrill), specimen with asymmetrical spicules; *e*, *Ellisella elongata* (Pallas), specimen from Fort Walton, Fla.; *f*, *Ellisella elongata* (Pallas), specimen from *Oregon* station 603; *g*, *Ellisella funiculina* (Duchassaing and Michelotti).

depths from 858 to 1,813 fathoms; also two records from off northern Florida, 270 and 273 fathoms. The present material, from off Cay Sal Bank, constitutes the southernmost record for the species.

Family PRIMNOIDAE

Callogorgia verticillata (Pallas)

Straits of Yucatán: NE. of Cape Catoche, Yucatán: 22° 40.2′ N., 86° 36.6′ W., 206 fathoms; *Oregon* station 590, April 19, 1950.

Gulf of Campeche: Campeche Bank, west of Yucatán Peninsula: 21° 17′ N., 91° 18′ W., 20 fathoms; *Oregon* station 1048, May 13, 1954.

Gulf of Mexico: South of Mobile, Ala.: 29° 12′ N., 88° 34′ W., 32 fathoms; *Oregon* station 817, August 5, 1953.

Nicholas Channel: SE. of Cay Sal Bank: 22° 55′ N., 79° 16′ W., 240 fathoms, *Oregon* station 1341, July 1955.

Plumarella goësi Aurivillius

Nicholas Channel: SE. of Cay Sal Bank: 22° 55′ N., 79° 16′ W., 240 fathoms; *Oregon* station 1341, July 1955.

Plumarella pourtalesii (Verrill)

Nicholas Channel: SE. of Cay Sal Bank: 22° 55′ N., 79° 16′ W., 240 fathoms; *Oregon* station 1341, July 1955.

Straits of Florida: NW. of Cay Sal Bank: 24° 03′ N., 80° 30′ W., 150 fathoms; *Oregon* station 1349, July 1955.

Family ISIDIDAE

Acanella eburnea (Pourtalès)

Gulf of Mexico: SW. of Dry Tortugas, Fla.: 24° 16′ N., 83° 22′ W., 375 fathoms; *Oregon* station 1019, April 16, 1954. South of Pascagoula, Miss.: 29° 01′ N., 88° 24′ W., 355–475 fathoms; *Oregon* station 640, September 19, 1954.

ZOOGEOGRAPHICAL REMARKS

The alcyonarian fauna of the Gulf of Mexico is divided into a northern shallow-water element comprised of species that range northward to Chesapeake Bay, skipping south Florida, a southern shallow-water element made up of West Indian species, and a widespread deep-water element representing an extension of the Caribbean-West Indian fauna. Below about 100 fathoms, a number of species appear that are known from the north Atlantic or belong to genera that flourish in cooler, northern waters.

The shallow water West Indian element is best developed at the Dry Tortugas and Key West, where many Antillean species, such as *Antillogorgia acerosa*, flourish. On the Florida Bank the number of species diminishes rapidly to the northward and few species persist beyond the vicinity of Tampa. Little is known of the alcyonarian fauna of the Campeche Bank, because the most favorable bottoms are too rough to be dredged and so must be collected by hand. Collectors do not go there. It is known, however, that the typically West Indian *Antillogorgia acerosa* occurs there, and so it seems probable that the other shallow-water species would belong to the same fauna. The extent of the fauna is completely unknown. The northwest coast of Cuba is little better known, but it almost certainly has a purely West Indian fauna in both shallow and deep water just as do the lower Florida Keys.

The limits of the shallow-water Carolinian element in the Gulf of Mexico are demonstrated by the distribution of such species as *Leptogorgia virgulata* (Lamarck), which occurs from the Texas coast to west Florida, skipping most of peninsular Florida, to reoccur somewhere along the Atlantic coast and extend north to the latitude of the Virginia Capes. A few other species, including *Muricea pendula*, *Lophogorgia hebes*, and the newly rediscovered *Anthopodium rubens* Verrill, follow this pattern, but the fauna is not a very rich one.

The western Gulf coast, that is, the coast of Texas south to perhaps Veracruz in Mexico, so far as is known has a shallow-water Carolinian fauna, including *Anthopodium rubens*, *Muricea pendula*, *Leptogorgia virgulata*, *L. setacea*, and *Lophogorgia hebes*, and a deeper-water West Indian fauna represented by *Bebryce grandis*, *Thesea plana*, and *Ellisella atlantica*. The only sea-pansy on the coast of Texas seems to be *Renilla mülleri*, which extends south to Brazil, and I am not sure that records of *R. reniformis* from any part of the Gulf are correct. Additional dredging between 25 and 200 fathoms should reveal a larger fauna, which I antici-

pate will be largely or entirely West Indian.

The appearance of *Trachymuricea kükenthali* in the northern Gulf of Mexico is a matter of considerable interest. The type locality and all subsequent records, until now, are in Norway. *Protoptilum thomsonii*, which is also not rare in this region, likewise was first described from the north Atlantic.

OCTOCORALLIA OF THE TORTUGAS

Shallow-water, down to about 24 fathoms.

West Indian species:

Briareum asbestinum
Muricea muricata
Muricea laxa
Eunicea mammosa
Eunicea calyculata
Eunicea tourneforti
Plexaura flexuosa
Plexaura porosa
Plexaurella dichotoma
Plexaurella nutans (= *kunzei*)
Antillogorgia acerosa
Antillogorgia rigida (= *americana* non Gmel.)
Antillogorgia bipinnata
Gorgonia flabellum
Pterogorgia anceps
Pterogorgia citrina
Pterogorgia guadalupensis

Deep-water species, deeper than 25 fathoms.

West Indian species:

Telesto sanguinea
Telesto flavula
Diodogorgia nodulifera
Iciligorgia schrammi
Bebryce cinerea
Echinomuricea atlantica
Placogorgia mirabilis
Placogorgia tenuis
Scleracis guadalupensis
Scleracis petrosa
Thesea citrina
Thesea grandiflora
Thesea plana
Thesea rugosa
Thesea solitaria
Villogorgia nigrescens
Nicella guadalupensis
Ellisella barbadensis
Ellisella funiculina
Ellisella grandis
Plumarella pourtalesii
Callogorgia verticillata
Chrysogorgia desbonni
Chrysogorgia elegans
Trichogorgia viola
Acanella eburnea
Primnoisis humilis
Stylatula elegans

OCTOCORALLIA OF THE FLORIDA WEST COAST

Shallow water, down to about 25 fathoms.

Carolinian species (with southern limit):

Telesto sanguinea (Tortugas)
Leptogorgia virgulata (Sanibel I.)
Lophogorgia hebes (Key West)

West Indian species (with northern limit):

Plexaura porosa (Tampa)
Plexaurella nutans (Tampa)
Antillogorgia acerosa (Tampa)
Antillogorgia rigida (Marco)
Pterogorgia anceps (Tampa)

Deeper water, more than 25 fathoms. (Paucity of species probably due to inadequate collecting.)

Acanella eburnea
Leptogorgia euryale
Leptogorgia medusa

OCTOCORALLIA OF THE NORTHERN GULF OF MEXICO FROM CAPE SAN BLAS, FLORIDA, TO THE TEXAS COAST

Shallow water, down to about 25 fathoms.

Carolinian species:

Telesto flavula
Telesto sanguinea
Muricea pendula
Leptogorgia virgulata
Leptogorgia setacea
Lophogorgia hebes
Virgularia presbytes

West Indian species:

Thesea plana (Unusually shallow)
Renilla mülleri
Deeper than 25 fathoms.

West Indian species:

Acanthogorgia schrammi
Bebryce grandis
Echinomuricea atlantica
Scleracis guadalupensis
Placogorgia mirabilis
Swiftia exserta
Swiftia casta
Thesea grandiflora grandiflora
Thesea grandiflora rugulosa
[*Thesea plana* presumably occurs]
Villogorgia nigrescens
Ellisella elongata
Ellisella atlantica
Callogorgia verticillata
Leptogorgia stheno
Leptogorgia euryale
Leptogorgia medusa

Warm-water representatives of northern genera:

*Trachymuricea kükenthali**
Acanella eburnea
*Funiculina quadrangularis**
*Protoptilum thomsonii**
Acanthoptilum agassizii
Acanthoptilum oligacis n. sp.
Stylatula antillarum

* Species known from north Atlantic.

OCTOCORALLIA OF THE TEXAS COAST

Shallow water, down to about 25 fathoms:
Anthopodium rubens
Muricea pendula
Leptogorgia virgulata
Leptogorgia setacea
Lophogorgia hebes
Renilla mülleri
Virgularia presbytes

Deeper than 25 fathoms:

Bebryce grandis
Chrysogorgia elegans
Protoptilum thomsonii

OREGON STATIONS AT WHICH OCTOCORALLIA WERE COLLECTED AND THE SPECIES RECORDED FROM EACH

126. *Protoptilum thomsonii* Kölliker.
274. *Renilla mülleri* Kölliker.
295. *Muricea pendula* Verrill; *Leptogorgia virgulata* Lamarck.
314. *Protoptilum thomsonii* Kölliker.
436. *Antillogorgia acerosa* (Pallas).
489. *Acanella eburnea* (Pourtalès); *Chrysogorgia* sp.
534. *Anthothela* sp.
537. *Thesea plana* Deichmann.
539. *Bebryce grandis* Deichmann.
548. *Chrysogorgia elegans* (Verrill); *Protoptilum thomsonii* Kölliker.
549. *Chrysogorgia elegans* (Verrill).
590. *Thesea hebes* Deichmann; *Callogorgia verticillata* (Pallas).
603. *Ellisella elongata* (Pallas).
604. *Bebryce grandis* Deichmann; *Thesea grandiflora* Deichmann; *Thesea grandiflora rugulosa* Deichmann; *Villogorgia nigrescens* Duchassaing & Michelotti; *Stylatula antillarum* Kölliker.
640. *Acanella eburnea* (Pourtalès).
793. *Scleracis guadalupensis* (Duchassaing and Michelotti); *Ellisella atlantica* (Toeplitz).
817. *Callogorgia verticillata* (Pallas).
889. *Telesto sanguinea* Deichmann.
892. *Telesto sanguinea* Deichmann; *Placogorgia mirabilis* Deichmann; *Thesea plana* Deichmann; *Trachymuricea hirta* (Pourtalès).
897. *Scleracis guadalupensis* (Duchassaing and Michelotti).
944. *Leptogorgia stheno* (Bayer).
945. *Leptogorgia stheno* (Bayer).
1003. *Plexaurella nutans* (Duchassaing and Michelotti).
1004. *Telesto riisei* (Duchassaing and Michelotti); *Antillogorgia acerosa* (Pallas); *Eunicea* sp.
1019. *Acanella eburnea* (Pourtalès).
1047. *Muricea elongata* Lamouroux.
1048. *Acanthogorgia schrammi* (Duchassaing and Michelotti); *Callogorgia verticillata* (Pallas).
1093. *Protoptilum thomsonii* Kölliker.
1283. *Acanthogorgia schrammi* (Duchassaing and Michelotti); *Trachymuricea kukenthali* (Broch).
1328. *Plumarella pourtalesii* (Verrill).
1341. *Radicipes gracilis* (Verrill); *Plumarella goësi* Aurivillius; *Callogorgia verticillata* (Pallas).
1343. *Plumarella pourtalesii* (Verrill); *Callogorgia verticillata* (Pallas).
1349. *Placogorgia mirabilis* Deichmann; *Plumarella poutalesii* (Verrill).
1416. *Ellisella atlantica* (Toeplitz).
1421. *Stylatula antillarum* Kölliker.
1558. *Acanthoptilum agassizii* Kölliker.

REFERENCES

AURIVILLIUS, MAGNUS. *The gorgonarians from Dr. Sixten Bock's expedition to Japan and Bonin Islands 1914.* Kungl. Svenska Vet.-Akad. Handl. (3) **9** (4): 1–337, 65 figs., 6 pls. 1931.

BAYER, FREDERICK M. *New western Atlantic records of octocorals (Coelenterata: Anthozoa), with descriptions of three new species.* Journ. Washington Acad. Sci. **42** (6): 183–189, 1 fig. 1952.

———. *Remarkably preserved fossil sea-pens and their Recent counterparts.* Journ. Washington Acad. Sci. **45** (9): 294–300, 2 figs. 1955.

———. *Contributions to the nomenclature, systematics, and morphology of the Octocorallia.* Proc. U. S. Nat. Mus. **105:** 207–220, 8 pls. 1955.

DANIELSSEN, D. C. Forh. Vid.-Selsk. Christiania (1859): 251. 1860.

DEICHMANN, ELISABETH. *The Alcyonaria of the western part of the Atlantic Ocean.* Mem. Mus. Comp. Zool. **53:** 1–317, 37 pls. 1936.

JUNGERSEN, H. F. E. *Pennatulida.* Den Danske *Ingolf*-Expedition **5** (1): 1–91, 3 pls. 1904.

KÖLLIKER, A. *Anatomisch-systematische Beschreibung der Alcyonarien. Erste Abtheilung: Die Pennatuliden.* Abh. Senckenb. Naturf. Ges. **7:** 111–225; 487–602; **8:** 85–275, 24 pls. 1870–1872.

SPRINGER, STEWART, and BULLIS, HARVEY R., JR. *Collections by the* Oregon *in the Gulf of Mexico.* U. S. Dept. Interior, Fish and Wildlife Serv., Spec. Sci. Rep.: Fisheries No. 196. 1956. [Contains complete data for *Oregon* stations 1 through 1429, as well as lists of the Crustacea, mollusks, and fishes collected 1950–1955.]

ANNUAL REPORT OF THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the annual business meeting of the Anthropological Society of Washington on May 21, 1957, the following officers were elected for 1957–58: President, THOMAS GLADWIN; Vice President, HARVEY C. MOORE; Secretary, JOSEPH B. CASAGRANDE; Treasurer, BETTY J. MEGGERS. SAUL RIESENBERG and WILLIAM C. STURTEVANT were elected councillors on the Board of Managers to serve until 1960. The Secretary's report follows:

MEMBERSHIP

Present membership in the Society stands at 129 as compared with 134 a year ago. During the last year 16 new members were added, 7 resigned, and 11 were dropped for nonpayment of dues.

The Society notes with deep regret the passing of one of its oldest and most distinguished members, Dr. Frederick Webb Hodge, long associated with the Bureau of American Ethnology, who died in Santa Fe, N. M., on September 28, 1956, just 30 days prior to his 92d birthday.

Newly elected members are:

Mrs. Charles P. Baldwin
William M. Bass III
Margaret Clark
James C. Gifford
Mary Ellen Goodman
Joel Martin Halpern
Genevieve A. Highland
Mrs. Ruth P. Landman
Margaret Lantis
Madeleine Mathiot
Lawrence Oschinsky
David A. Reibel
Saul H. Riesenberg
Joan Rubin
William C. Sturtevant
George H. Vergine

PROGRAM FOR 1956–57

As agreed at the last Annual Meeting, the program for 1956–57 was devoted to reports on research undertaken by Society members and others resident in the Washington area. The program arranged by Gottfried Lang, Program Chairman, included the following lectures:

October 16, 1956, Carl F. Miller, "Field Impressions of the Archeology of Russell Cave, Northern Alabama."
November 20, 1956, Richard P. Schaedel, "The Development of Urban Centers in Prehistoris Peru."
December 10, 1956, Marshall T. Newman, "Coordinated Biological Studies on Indians of Hacienda Vicos, Peru."
January 29, 1957, Martin Gusinde, S. V. D., "The Pygmies of Schraeder Mountain, New Guinea."
February 19, 1957, Mary Ellen Goodman, "Social Concepts, Values, and Attitudes in Japanese Children."
March 19, 1957. (Joint Meeting with the District of Columbia Sociological Society.) Symposium on "Findings in a Study of an Inbred Mixed Racial Isolate in Maryland," Calvin L. Beale, Chairman; William H. Gilbert, Rev. Thomas Harte, Carl J. Whitkop, and Paul Schmidt, speakers.
April 16, 1957, Lawrence Krader, "A Survey of Soviet Anthropology, Based on a Recent Visit to the U. S. S. R."
May 21, 1957, Joseph B. Casagrande, "Language Pattern and Cognitive Functioning: A Study in Navaho Psycholinguistics."

1957–58 DARWIN ANNIVERSARY PROGRAM

In commemoration of the 100th anniversary in 1959 of the publication of Charles Darwin's *Origin of Species* the Society has planned a program for 1957–58 on the general theme of evolution and anthropological theory. The following persons have accepted invitations to address the Society at meetings to be scheduled for the months indicated:

Ernst Mayr, Museum of Comparative Zoology, Harvard University, October
T. Dale Stewart, Smithsonian Institution, November
Robert Braidwood, University of Chicago, December
Leslie A. White, University of Michigan, January
George P. Murdock, Yale University, February
Joseph H. Greenberg, Columbia University, March
A. I. Hallowell, University of Pennsylvania, April
Clyde Kluckhohn, Harvard University, May

PUBLICATIONS

A selection of the papers presented in the Society's 1955–56 program on "Man and His Environment" will shortly be published by the Pan American Union in cooperation with the Society. Lawrence Krader, who arranged the program, served as editor of the volume which will include the following papers:

"Ecological Potential and Cultural Growth in Meso-America," by Eric Wolf and Angel Palerm.
"The North American Grasslands: Man-Made or Natural?" by Waldo R. Wedel.

"The Ecology of Human Diseases," by Jacques M. May.
"Environment and Culture in the Amazon Basin," by Betty J. Meggers.
"Man and Nature: Problems and Perspectives," by Lawrence Krader.

During the past year the papers presented in the Society's 1954–55 program were published in a volume entitled *Some Uses of Anthropology: Theoretical and Applied*. The book is offered for sale by the Society at $1.50 per copy. A report on the distribution of the volume as of April 22, 1957, is included in the Treasurer's Report for 1956–57.

It may also be noted that the printing of 1,000 copies of the Society's 75th Anniversary Volume, *New Interpretations of Aboriginal American Culture History*, is entirely exhausted.

OTHER ACTIVITIES

The Society has been honored to receive an invitation from the American Anthropological Association to serve as host for the 57th Annual Meeting of the Association to be held in Washington at the Shoreham Hotel on November 20–23, 1958.

In keeping with the practice of recent years, the Board of Managers again voted to contribute the sum of $25 toward the support of the 1957 annual Washington Science Fair sponsored by the Washington Academy of Sciences.

JOSEPH B. CASAGRANDE, *Secretary*

DR. KIESS RETIRES

On October 31, 1957, Dr. CARL C. KIESS, a spectroscopist, retired from the National Bureau of Standards. His 40 years of service brought honor and distinction to the Bureau, the Department of Commerce, and to Government service in general. Dr. Kiess early realized the significance of the regularities in complex spectra—clues to the structure of the atom. His monographs on the spectra of chromium, in which he classified over 5,000 lines, culminating 30 years of work on these atoms, are remarkable achievements in science. Similar studies of molybdenum, iodine, and tantalum atoms, now in course of publication, are a fitting climax to his long career of scientific research.

During World War II Dr. Kiess, in collaboration with Dr. C. J. Humphreys, determined the electronic configuration of the uranium atom and thus established for the first time the existence of a second series of rare-earth elements. This brilliant discovery is of far-reaching importance today in the study of the heaviest elements in the periodic table.

In the hands of Dr. Kiess the spectroscope is truly a "master key to the universe." The chemist, the metallurgist, the spectrographer, the physicist, and the astrophysicist draw upon the wealth of reliable information in his collection of more than 80 important scientific papers.

He has served as the authority on astronomy and astrophysics at the National Bureau of Standards. His work on silicon atoms enabled him to identify conspicuous lines in the spectrum of the sun, lines that had defied identification for years. Similarly, phosphorus was first detected in the sun's atmosphere as a result of Dr. Kiess's laboratory studies of this atom.

In 1955 Dr. Kiess received the Department's Exceptional Service Award for outstanding scientific research in spectroscopy, through the discovery of atomic energy levels of the highly complex atoms, for precision measurement of wavelength, and for basic contributions to astrophysics.

The final test of science is not whether its accomplishments add to our comfort, knowledge, and power, but whether it adds to our dignity as men, our sense of truth and beauty.—DAVID SARNOFF.